

ATOLL RESEARCH BULLETIN

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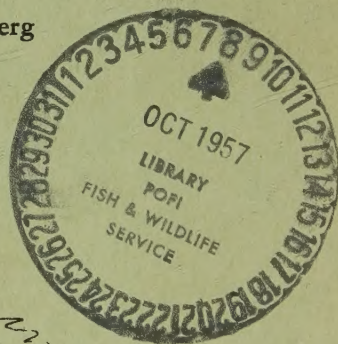
by J. T. Marshall, Jr.

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It is a pleasure to commend the far-sighted policy of the Office of Naval Research, with its emphasis on basic research, as a result of which a grant has made possible the continuation of the Coral Atoll Program of the Pacific Science Board.

It is of interest to note, historically, that much of the fundamental information on atolls of the Pacific was gathered by the U. S. Navy's South Pacific Exploring Expedition, over one hundred years ago, under the command of Captain Charles Wilkes. The continuing nature of such scientific interest by the Navy is shown by the support for the Pacific Science Board's research programs, CIMA, SIM, and ICCP, during the past ten years. The Coral Atoll Program is a part of SIM.

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No. 51

Observations on French Frigate Shoals, February 1956

by

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Washington, D. C.

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Observations on French Frigate Shoals, February 1956

by
Arthur Svihla

A visit was made to French Frigate Shoals from February 11 to February 21, 1956, in order to study the life habits, distribution and abundance of the Hawaiian Seal (Monachus schauinslandi). Incidental to the primary purpose of the trip, observations and collections of other animals and plants were made.

I am indebted to the U. S. Coast Guard for transportation to French Frigate Shoals as well as for assistance and cooperation while there.

All collections were made on Tern Island due to inability to visit the other islands in this group. Specimens of plants and terrestrial arthropods which were collected have been deposited in the Bernice P. Bishop Museum, Honolulu, Hawaii.

Tern Island consists largely of the barren landing strip but there is a small area of approximately three acres in extent which still retains some of the original flora. This consists of various grasses (some of which are undoubtedly introduced), the beach morning-glory (Ipomoea pes-caprae) and Scaevola. Around the buildings of the Loran Station three coconut trees and several clumps of Casuarinas have been planted. The trunks of the three coconut trees are about one foot high and seem to be established. The Casuarinas, planted in front of the mess hall are about 15 feet high. They too appear to be growing well.

Under blocks of coral above the beach line as well as under discarded boards were found sow-bugs, crickets, cockroaches, earwigs and spiders. Since soil from Honolulu had been brought to Tern Island, these arthropods might have been introduced in this way. A few house flies were present in the buildings.

The only nesting bird on Tern Island was the Laysan Albatross. Each nest had a single chick about a month old. A few Black-footed Albatross were also present but were not nesting although they were going through the characteristic dancing antics. About 15 Turnstones frequented the vicinity of the mess hall where scraps were thrown to them. Only 1 Sanderling was seen. On several occasions Man-of-War birds were observed flying over the island. Six Fairy Terns flew over the island one day. The most numerous birds were the Sooty Terns which appeared every evening just before or after sunset over the shallow lagoon where they were apparently feeding. Their loud calls could be

heard as soon as they appeared and continued until they disappeared about 3:00 o'clock each morning. I have been informed by one of the men who was stationed there that later in the year these birds nest in enormous numbers on the island, hence the name Tern Island.

The mammals on the island consisted of a fluctuating population of Coast Guard personnel, two house cats (said to be of the same sex) which fed to a certain extent on the birds; two dogs, pets of the men, and the Hawaiian Seal. Four of these mammals were seen on Tern Island. On the return flight to Honolulu a count of seals was made. A total of 32 seals were seen on February 21, 1956, from the following islands of the group:

Shark (didn't fly over)		
Tern	0	(4 day before)
small island in front of Trig	4	
Trig	4	
Skate	10	2 turtles
Whale	7	1 turtle
Round	2	
Mullet	3	
East	1	
on reef in lagoon	1	

32

The plane did not fly over Gin, Little Gin or Disappearing Islands.

The previous count of Hawaiian Seals occurring on French Frigate Shoals was 16. This mammal is apparently on the increase here. On some of the islands the seals were seen in pairs, the males could be distinguished by their larger size, heavier forequarters and dark brown color from the smaller, more slender light brown color females. Pairing was apparently occurring here at this time of the year.

Several large sea turtles were also seen from the air.

ATOLL RESEARCH BULLETIN

No. 52

Zonation of corals on Japtan Reef, Eniwetok Atoll

by

Eugene P. Odum and Howard T. Odum

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THE PACIFIC SCIENCE BOARD

National Academy of Sciences--National Research Council

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Zonation of Corals on Japtan Reef, Eniwetok Atoll

by

Eugene P. Odum, University of Georgia, Athens

Howard T. Odum, Institute of Marine Sciences, Port Aransas, Texas

At the time of the publication of our paper "Trophic Structure and Productivity of a Windward Coral Reef Community on Eniwetok Atoll" (Ecol. Monogr., 25: 291-320. 1955) only tentative identifications of corals, mostly to genus, could be designated since our reference specimens, sent to the National Museum for study, had been returned with only partial identification of some specimens. Since exact identification to species was not necessary in our analysis of total structure and metabolism of the reef, code numbers were used in the text and tables of our paper, pending more complete determinations.

Upon his return from an overseas trip, Dr. John W. Wells of Cornell University, kindly consented to examine our collections during the summer of 1955. He has returned the material to us with his determinations of species. Since the Japtan Reef which we studied is located near the Marine Laboratory on Parry Island and may be frequently visited by workers at the laboratory it seems especially desirable to make available the final identifications. The Japtan reef, being relatively undisturbed, can serve as a "control" for studies of reefs more directly affected by nuclear weapons tests.

The series of corals was collected in a transect across the windward, inter-island reef about one-fourth mile north of Japtan (Muti) Island on Eniwetok Atoll, Marshall Islands. This reef, the physiographic zonation, and the location of sample quadrats have been fully described and pictured in the above mentioned paper. As shown in Figure 1, the reef at the study transect point exhibited 6 distinct zones. No collections could be made from the windward buttress zone. The other 5 zones are designated in Figure 1 and Table 1 as follows: A. Coral-algal ridge (breaker zone). B. Encrusting zone. C. Zone of small heads. D. Zone of large heads. E. Zone of sand and shingle with scattered large heads. The species of corals collected from these zones are tabulated in Table 1. Code numbers correspond to numbers listed in text and tables of the Ecological Monograph paper.

As would be expected, the gradients (from sea to lagoon) in depth of from about 6 inches to 30 feet and more and in current velocity from about 0.5 meter to less than 0.1 meter per second at "average" tide conditions result in sharp changes in species composition along the reef transect. The conditions at low spring tides are probably critical for many species since current velocities are greatly reduced; only a few inches of water may cover the windward zones and the large heads of Zone D may project a foot or more above water for several hours. Porites lobata appeared to tolerate the widest range of conditions as it could be found over most of the reef. Millepora platyphylla was the only species which appeared to exhibit a discontinuous distribution; it was an important species in Zones A and B and again in Zones D and E but not in Zone C. However, the growth forms or "ecotypes" of this species were quite different on the front and back reef; on the former, this coral was largely encrusting while in the deeper water zones the tall, branched finger-like form was prominent.

TABLE 1. Zonation of Corals on Japtan Reef, Eniwetok Atoll

SPECIES	Code Numbers	REEF ZONE				
		A	B	C	D	E
<u>Pocillopora danae</u> (E. and S.)	A-1	X				
<u>Acropora</u> sp. (Encrusting type)	B-1	X	X			
<u>Millepora platyphylla</u> H. and E.	B-2,E-1	X	X		X	X
<u>Favites halicora</u> (Ehrenb.)	B-4		X			
<u>Pocillopora verrucosa</u> (E. and S.)	B-7		X			
<u>Plesiastrea versipora</u> (Lam.)	B-3,B-5,C-2		X	X		
<u>Favia pallida</u> (Dana)	B-8,C-3		X	X		
<u>Porites lobata</u> Dana	B-6		X	X	X	
<u>Favites abdita</u> (E. and S.)	C-4			X		
<u>Cyphastrea chalcidicum</u> (Forsk.)	C-5			X		
<u>Porites lutea</u> M.-E. and H.	C-6			X		
<u>Pocillopora elegans</u> Dana	C-8			X		
<u>Acropora tubicinarina</u> (Dana)	C-9			X		
<u>Acropora conferta</u> (Quelch)	C-7			X	X	
<u>Acropora humilis</u> (Dana)	C-10,D-7			X	X	
<u>Echinopora lamellosa</u> (Esper)	C-11			X	X	
<u>Favia stelligera</u> (Dana)	C-13			X	X	
<u>Acropora corymbosa</u> (Lam.)	D-9				X	
<u>Acropora recumbens</u> (Brook) (?)	D-12				X	
<u>Montipora verrilli</u> Vaughan	D-3				X	
<u>Montipora foveolata</u> (Dana)	D-4				X	
<u>Goniastrea retiformis</u> (Lam.)	D-1				X	
<u>Stylophora mordax</u> Dana	D-8				X	
<u>Lobophytum pauciflorum</u> (Ehr.)	D-10				X	
<u>Millepora murrayi</u> Quelch	E-2					X
<u>Heliopora coerulea</u> (Pallas)	E-3					X
<u>Turbinaria globularis</u> Bernard	E-4					X

As may be seen from Table 1, only three species were found along the breaker zone, which on the Japtan reef was largely covered by algae. On Zone B, the encrusting Acropora and Millepora and small "doughnut-shaped" heads of Porites, Favites, Plesiastrea and Pocillopora were most conspicuous. On Zone C the massive types of Favids and Porites (two species) were characteristic while in Zone D the branching Acroporas were conspicuous. Within the extensive "zone of large heads" there was a noticeable sub-zonation with the Acropora, Porites, Pocillopora and Stylophora in Zone D while Heliopora and the two species of Millepora formed a distinct zone lagoonward which is designated as "E". The scattered large heads on the lagoon edge were largely Turbinaria but we did not use the aqua-lung to investigate the deeper waters. Undoubtedly, there are other species beyond Zone E.

It should be pointed out that species B-3 which was designated as "Leptastrea" in Tables 1, 2, 3, 5 and Figure 7 of our monograph (Odum and Odum, 1955) should be Plesiastrea versipora. This species was of a special interest to us in having multiple bands of skeletal algae. Also of special interest were the two species of Favites (B-4, halicora and C-4 abdita) which had about twice the chlorophyll content per square centimeter of surface as any other species studied.

In addition to the species shown in Table 1, which were the ones actually collected along the study transect, the following additional species were picked up from other parts of the Japtan reef.

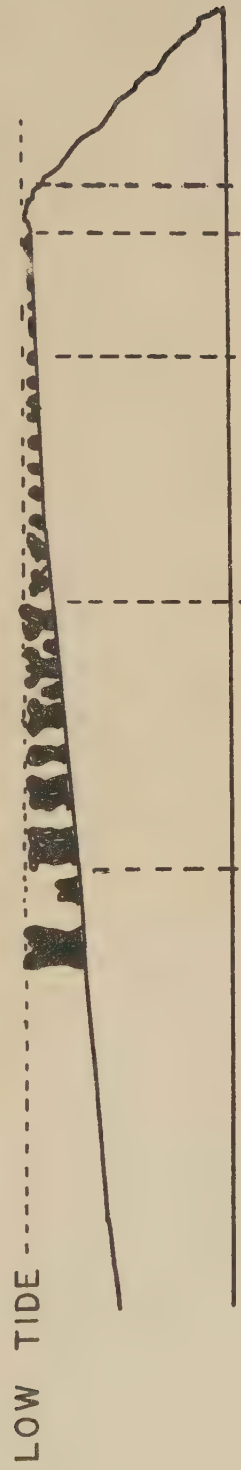
Astreopora myriophthalma (Lam.) (M-29)
Platygyra rustica (Dana) (M-19)
Montipora composita Crossland (M-3)
Distichopora irregularis Moseley (M-12)

Finally, the species of Lobophyllia (R-1) which we used to determine polyp and algae biomass (see Table 1, Odum and Odum, 1955) has been determined to be L. corymbosa (Forsk.) by Dr. Wells. We did not find this species on Japtan but collected it on the leeward side of the atoll at Rigili Island. It was used because the large polyp size made possible dissection of components for comparison with the indirect methods used with other species.

Figure 1. Diagram of the Japtan reef transect, side view (upper) and aerial view (lower) showing zonation referred to in text and in table 1.

PHYSIOGRAPHIC ZONES →

SAND-SHINGLE LARGE HEADS SMALL HEADS ENCRUSTING RIDGE BUTTRESS



CORAL ZONES →

E D C B A



SEA

← CURRENT

LAGOON

ATOLL RESEARCH BULLETIN

No. 53

Slicks on ocean surface downwind from coral reefs .

by

F. R. Fosberg

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Slicks on Ocean Surface Downwind from Coral Reefs ^{1/}

by
F. R. Fosberg ^{2/}

During general investigations of certain atolls of the northern Marshall Islands in 1952 (Fosberg, 1955) a phenomenon was noticed that seems worthy of the attention of oceanographers and geologists, although no explanation is offered for it. This is the occurrence of narrow, elongate strips of smooth water, resembling the effect produced by a film of oil on the surface, extending downwind from the coral reefs.

This appearance was first noticed in the lagoon of Ujae Atoll on March 4, 1952, and was observed repeatedly thereafter for more than a week along the windward reef in the southern half of the atoll. A brisk trade wind was blowing, and the surface of the lagoon was covered by a close pattern of ripples, wavelets, and small waves. Perpendicular to the reef and exactly in the direction of the wind were numerous parallel linear streaks, varying from a few centimeters to a meter in width, of perfectly smooth water. These extended several hundred yards downwind. In them there was an abrupt smoothing of the surface disturbance of the water and usually a small accumulation of small bubbles and flecks of foam in a broken line near the center of the streak. The streaks seemed to be of different ages, the younger ones having very clearly defined edges, the older ones becoming broken up or braided in pattern. They tended to become more broken up as the distance from the reef increased, also broader with distance. On a very rough day their boundaries were not clear, and the choppiness was not altogether smoothed out. On a day with only a very gentle breeze the whole streak was not straight but a bit irregular. At about 300 m. from the reef, on the calmer day the streaks became as much as 6 to 8 m. wide. On March 9 similar streaks were seen in the open sea to the leeward of the north end of Ujae Atoll, downwind from Bikenkar and Enelamoj Islets and their connecting reef. These were very well developed, even directly in the lee of the islets. The largest seemed to correspond to large reentrants or surge channels in the reef.

On March 18 similar streaks were seen on Wotho Atoll, in the south part of the lagoon inside the east reef, some opposite the open reef, some inward from the long sand islet on this reef. On March 21 a very good opportunity was afforded to study these streaks inside the north reef of Wotho, west of Eneobnak Islet. Here are several channels crossing the reef, broad toward the seaward side of the reef, narrowing toward the western projection of the islet and sweeping westward around this projection before entering the lagoon. On the reef they run between flats of reef conglomerate and rubble tracts lying on the reef flat. A fairly strong current was flowing inward from the sea to the lagoon. In these channels the slicks described above were

^{1/} Publication authorized by the Director, U. S. Geological Survey.

^{2/} Botanist, U. S. Geological Survey.

very prominent, following the direction of the wind rather than that of the current, though these directions were only a few degrees apart. Although previous observations were all made from small boats, here it was possible to examine the streaks much more closely while wading in waist-deep water. Careful examination revealed no iridescence, whatever. The boundaries were extremely sharp. There was a suggestion of a difference in the feel of the water in the streaks from that nearby, but nothing very tangible or describable. There was no difference in taste or flavor. An attempt was made to follow the streaks to their sources, which seemed to be in the rubble tracts to windward, but this was unsuccessful, as the streaks gradually became invisible in the very quiet water as the rubble tract was approached. There was nothing in the rubble tract to suggest an origin for this phenomenon. There seemed little chance that oily material from the open sea could be responsible for the phenomenon here, though such an origin could not be excluded.

On March 24 similar streaks were seen in the open sea to the leeward of the south half of Bikar Atoll. They were quite numerous, but where the observations were made, from the deck of the ship a quarter to half a mile from the reef, they were rather braided and broken up, but some were still fairly strong. On March 25, at Pokak Atoll, the northernmost of the Marshalls, such slicks were conspicuous at sea on the leeward side of the leeward reef, especially near the single channel through the reef. They extended for several miles downwind, becoming very diffuse at that distance. Here they were only observed from the deck of the ship.

All of the above observations were made in the spring, in a season of strong trade winds. Another visit was made to Pokak and Bikar in July and August, in much calmer weather. A special attempt was made to observe this phenomenon further, but then it was much more difficult to see the slicks clearly. What appeared to be the same type of streaks were seen several times; however only once, on August 9, were unequivocal observations made. This was in the lagoon of Bikar Atoll where a few not especially clear or sharp streaks were seen inside the windward reef between Almeni and Jaboero Islets. There seems no doubt that the phenomenon occurs during these calmer months, but because of the weakness of surface disturbance there is so little contrast that the slicks do not show up very well.

The above observations form all of the factual data to be considered. There seems little doubt that the phenomenon is a real one that is reasonably constantly associated with coral reefs, at least in the northern Marshalls area. That it was not seen near any of the eight other atolls visited earlier in the same expedition is probably simply the result of attention not having been called to it previously. The expedition did not primarily concern itself with the ocean but with reefs and islets. After the slicks were first noticed they could usually be found in any similar situation to the leeward of reefs in brisk weather.

The appearance of these slicks strongly suggests the presence of minute quantities, perhaps monomolecular films, of some substance that strongly alters the surface tension of the sea water. The smoothing out of ripples is abrupt, localized, and of considerable duration, not shifting and inconstant as would be expected of phenomena due solely to wind interacting with the surface of the water (see Langmuir, 1938). The dependence of slick formation on the presence of films of organic matter on the surface of the water has been stressed by most authors who have discussed such phenomena in recent years (Dietz and LaFond, 1950; Ewing, 1950a, 1950b). The combined influence of organic films and effects of strong winds, as suggested by Ewing (1950a, b) should not be disregarded as a possibility, though the "braided" appearance of old slicks contrasted with the sharpness of new ones parallel and simultaneous with them is hard to reconcile with any wind-induced phenomenon. The nature of the pattern observed in the Marshall Islands does not at all resemble the pattern of light and dark bands in the Gulf of Panama discussed by Woodcock and Wyman (1947) as shown in their photographs in plates 6 to 8.

The arrangement of the streaks, at irregular intervals running down wind from the reef, suggests the possibility of frequent emission of minute quantities of some oily material from the reef or from some organism connected with the reef. F. S. MacNeil (in conversation at the time) reported seeing small emissions of bubbles coming out of reefs in places. The possibility has not been overlooked that these slicks may be due to waste oil (from steamships) that may be washed over the reef from the windward side. This, however, seems precluded by the observation of the same phenomenon to leeward of long islets where no water could possibly come over from the windward side. These islands are, also, far from lanes of heavy ocean traffic at the present time. There seems little doubt that these streaks originate on the reef itself.

These facts are placed on record in the hope that either a convincing solution to the problem of the origin of the slicks may occur to someone else or that further investigation may be deemed worth while.

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ATOLL RESEARCH BULLETIN

No. 54

Field notes on atolls visited in the Marshalls, 1956

by

Herold J. Wiens

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FIELD NOTES ON ATOLLS VISITED IN THE MARSHALLS, 1956

by

Herold J. Wiens

Since the spring of 1955 I have been engaged in a study for the Pacific Science Board of the National Academy of Sciences-National Research Council in which I am attempting to analyze, synthesize and generalize to the extent of my capacity certain scholarly data and other published information about coral atolls and reef islands in the tropical Pacific. These data pertain to the physical environment and general ecology of such atolls and islands, to man's situation and role in them, and to the inter-relationships between man and his physical and biological environment on them. In the summer of 1954 I was the geographer on the Pacific Science Board expedition to Kapingamarangi in the Eastern Carolines and briefly visited 5 other atolls and an uninhabited reef island in this region. With the goal of gaining better insight and perspective on the aspects of coral atolls and reef islands in different precipitation zones, I pursued further field studies in the summer of 1956, visiting briefly or for longer periods eleven different atolls and two single reef islands in the Marshalls. Although pre-planning of itineraries proved to be rather futile, it turned out that I was able to visit representative atolls and islands in the dry northern, intermediate humid and wet southern parts of both the eastern and the western chains of the Marshalls.

The notes presented here generally were typed up with little change from field notes written while on the atolls described or immediately after departure from them. They should be viewed only as field notes, therefore, and not as systematic studies of any sort. All types of information striking my attention were jotted down. Most were from direct observations; others were derived from informants. The amount of time spent upon any atoll differed from that spent on others, and I had no control over my transportation schedules. Traveling was done by small 50-70 ft. schooners for the most part, although two or three trips were made by air. On some atolls there was time only for one to several hours of ground examination during daylight. On others, several days were available, although owing to heavy continuous rains on such atolls as Arno and Ebon, not all the time in such longer stays could be used to advantage. The distribution of the islets along scores of miles of reefs, the changing state of the tide interrupting travel between islets, the lack of local transportation, and the fact that visiting schooners stop only at one or two of the scattered bits of land combined with the briefness of the stops in limiting my observations. These limitations account for the fragmentary character of these observations and for their unequal amount and quality.

The reader is begged indulgence for these deficiencies. The notes are offered in spite of them if for nothing else than that some of these atolls are seldom visited, and little is known of them. I gratefully acknowledge the aid and cooperation of the United States Naval authorities on Kwajalein and of the District Administration of the Trust Territory at Majuro and

Ebeje (Kwajelein) under District Administrator Maynard Neas. I wish to express my thanks to the Marshallese on all the atolls and islands who showed me their kindness and hospitality in numerous ways, especially to Capelle, Melander and Felix DeBrum and to Maas Hone of Likiep Atoll; to Maida Kabua of Ailinglaplap; and to Nashon, magistrate at Ebon, and to his father's family. For kindnesses shown in my marine voyaging, I want to thank Captain Rudolph Moeller of the Administration schooner Frela, Walter Milne of the trading schooner Raete, and Father Donohue of the Catholic Mission schooner St. Joseph. I am indebted to Clarence and Sachi Takeuchi and Milton Sidaris of the District Administration for their kind hospitality at Majuro and Jaluit respectively, and to District Anthropologist Jack Tobin for his cooperation and information. Most of all, I wish to express my appreciation for the exceptionally cordial hospitality and kindnesses shown me by Richard Umhoefer, District Administration Representative at Ebeje, and by Mrs. Umhoefer.

Ailinglaplap Atoll

Woja Islet was examined during a brief stop of an hour or so. The headman of the village is Melan; an interpreter for me was Menajo who conducted me on a walk through most of the "village" which has some 300 people.

A relatively luxuriant vegetation grows on this islet. Two large trees (Hernandia sonora) were seen on lagoon shore. Two types of taro-like plants grow here: one wot (Alocasia macrorrhiza) is reported as not being good to eat because of microscopic needle-like crystals in it; however, many plants of these were seen growing wild underneath the breadfruit and coconut trees; the other is called yaroj or iara (Cyrtosperma chamissonis), and is eaten. Breadfruit grown here are of three types called botagetok, mejwan, and pukrol. Kengi or gengi (Pemphis acidula) occurs both on ocean and lagoon side and is used for making charcoal among other uses. A decorative plant or weed is deroj or diros (Pseuderanthemum carruthersii) with purplish green leaves. A creeper, probably a morning glory vine and a plant identified as ninkijei were observed. Asplenium nidus fern occurs widely. On the windward lagoon shore a rather marked development of stratified beach-rock occurs with a strong dip lagoonward, the layers well eroded and clearly defined.

The longest islet on Ailinglaplap has two names, for the two settlements found at the respective ends. The eastern end is called Airik and the western end Buoja, with an estimated 500 and 300 people respectively, according to the medical aide, Maida Kabua. A channel lies between Buoja and the next islet, Bikajla, and a sheltered anchorage is found on one side of the channel adjacent to Buoja.

The long islet is about 7 miles long in a large bow shape; it becomes very narrow (about 100 feet wide) in the middle section and is widest at Airik the larger of the two settlements and the location of a newly built Protestant church of rather elaborate construction and colorful decoration. The islet is noted for the development of a tidal basin with mangrove swamps (not true swamps) in which three types of mangrove are found, bulabol

(Sonneratia caseolaris), jong (Bruguiera conjugata), and eoek (Rhizophora mucronata); the latter has an oblong shaped leaf; photos of all three types were taken. One Hernandia sonora seen was one foot in diameter. Merlap (Canavalia microcarpa) of a light purple color was observed. The islet as a whole impressed one with the abundance of pandanus and tall breadfruit trees. At the tip near Airik the coconut trees are in sandy soil and tend to have a chlorotic color and are low. However, a well with water tasting fresh occurs only 30 feet from the lagoon shore, with surface water (at the tidal stage observed) of four feet below the surface of the ground. Seagrape bushes and a variety of croton bushes are common decorative shrubs along the sides of the road traversing the islet. Other common trees are Hibiscus, Plumeria, Calophyllum and Barringtonia.

Residences observed on Buoj and Airik appear better than in most Marshallese settlements, about on a par with those of Likiep and Ebon. The magistrate here is Jorninea; Luta is headman of Buoj and Leiran is headman of Airik. Both Marmoru and Maida speak English well. Albert, a Gilbertese married to a local Marshallese Catholic is a Protestant who is building a store to compete with Mieco. He speaks excellent English. A neat, clean medical clinic with two rooms stands a couple of houses from the home of Maida Kabua who is a descendant of the Kabua kings whose graves are situated across the road from Maida's house in Buoj. Maida said that serious diseases or accidents rarely occur; skin infections, eye infection, and colds are the commoner afflictions. The new Protestant Church almost completed and subsequently dedicated in early August 1956 was designed by a Marshallese carpenter trained in his profession by the Japanese during their period of occupation. He has displayed a good deal of imagination in decoration, if his color schemes are a bit garish in their primary colors.

Bikajla Islet across from Buoj shows an extraordinary development of coral boulders lying loosely, and apparently permeable to salt water for about 250 feet inland from the ocean-side. In the outer parts dense growths of Morinda citrifolia and Guettarda lie in almost rainforest gloom, with liana-like vines of a Wedelia-type weed falling from their crowns and hanging leafless in the perpetual shadows. Farther inland Bruguiera conjugata provides dense shade, intermingled with some Pandanus, its gnarled, humped-up roots covered with a hairy green coat of algae or lichen. The land forms a low trough here. Asplenium nidus and Nephrolepis acuta grow on the trunks and old stumps of coconut and other trees. Throughout the seaward 200 feet or so pandanus jungle predominates. Few coconut trees occur until, toward the interior, a rise on the lagoon-side of the trough and fresh-water-holding soil have allowed a dense growth of young coconut sprouts among older trees. The islet looks as if no man had disturbed things for decades.

A brief stop was made at Bikar Islet on the north end of the atoll. Here only one or two residences were inhabited. The south end of Bikar appeared to be a relatively new addition of sand with numerous pioneer plants. Strong wave erosion on the lagoon shore has almost destroyed the rock-lined road built during Japanese or German times, having undercut 10-20 feet of the lagoon shore land. Orange colored algae cover the reef rock extending into the lagoon side of the inter-islet channel on the south side of the islet.

Ailuk Atoll

Ailuk Islet is the main residential islet, but is rather small, not more than 1500 feet long nor any wider. No unusual topographic features were observed. There are no very large islets on Ailuk Atoll.

Breadfruit trees were numerous and mostly 40 feet tall or lower, although several were up to 60 feet tall with trunks more than 3 feet in diameter, indicating that the storm of 1951 probably had not been so damaging as it was at Utirik. Generally the vegetation under the coconut trees was similar to that at Utirik and Mejit, with arrowroot very prevalent everywhere. Many taro pits were seen in the interior, but in several only small parts were planted to taro. Most of the pits had been abandoned to weeds.

On the north channel side of the islet Pemphis is the main bush, while Scaevola becomes more common on the ocean side beaches. Numerous bushes of ulej (Clerodendrum inerme) grew in the vicinity of the taro pits.

Numerous large sailing outriggers sailed in to the waters of the lagoon (village) from the relatively large islet at the opposite end of the lagoon.

On the oceanside someone had written just before sundown in the wet sand a long line of words carefully inscribed in Marshallese followed by the English sentence: "Please remember me always, Nathan," apparently intending the inscription to be washed away by the next high tide and so having the message conveyed to the heart of the loved one.

Arno Atoll

Ine Islet has an unusually high sand ridge on the lagoon side and in the northern part of Ine village. A fine wide sand beach of moderate firmness for walking is found most of the length of Ine on the lagoon side. The seaward side of Ine has a high level coral boulder rampart over 100 feet wide sloping gently toward the low center of the islet which is well cleared of undergrowth. Some taro pits are in use for taro, but others have been abandoned. Much breadfruit is produced from the numerous trees, and there appears to be an abundance of banana and pandanus trees. The village houses are for the most part rather poorly constructed and maintained. The village school is in a dilapidated condition which is inexcusable; walls rotted away and tin roof full of large holes; the floor wet with water and littered with debris. A dedication plaque surmounted with an Air Force Wings insignia indicates the building was constructed or completed December 3, 1944, when the C.O. of the area was Lt. Col. C. V. Burnett, stationed at Majuro.

Kojboy (Kij-Bwe) Islet near one of the passes provides a sheltered anchorage for ships wishing to anchor just inside the pass. It has a fine sand beach facing the lagoon, with a coarse boulder and cobbled beach on the windward side above a solid rock bench rising two feet above the reef flat. This bench has been well smoothed by the grinding of sand and gravel worked back and forth by waves. Inward from the beach coarse coral boulders loosely

piled and blackened by algae reach 30-100 feet toward the middle of the islet. On this, Scaevola is most prevalent, followed by Pandanus and Guetarda. On the end of the islet facing the pass, the coral boulders reach inward to greater depth in a series of ramparts.

This type of islet structure is typical of many observed throughout the Marshalls as well as at Kapingamarangi in the Carolines. It leads me to believe that the coarse coral blocks on the seaward side, up to one or two feet in diameter and loosely piled, must have been deposited at one time in a single major storm. The modern beach fronting this layer of blocks at Kojboy, for instance comprises mostly smaller gravel, well rounded and polished and piled in a ridge or sometimes in two or more ridges above the solid rock bench and forming the beach proper. At other islets where wave action has eaten inward upon the islet, such coarse coral boulders, little worn and rounded by wave action, have been observed to be underlain by well worn and rounded gravels and finer materials.

Along the end of Kojboy Islet facing the pass, the swift current and tidal pounding have left no sand accumulation as often is the case at points facing shallow inter-islet channels which are dry at low tide. The beach accumulation forming the lagoonward-turning point of the islet here comprises coarse cobbles and gravels overgrown with a scattered growth of Scaevola.

In the interior of Kojboy, the ground under the coconut palms has been kept cleared except for low shrubs, ferns and grasses. One or two families have residence houses here, but the taro pit in the center is not used for taro, but has been abandoned to weed growth.

Like the other islets observed, Arno Islet has a similar coarse cobble beach on the seaward side, with a fine sandy beach on the lagoon side. On the eastern end where the island becomes attenuated and connects with a very narrow (50-80 feet wide) islet east of it, the connection is a sand ridge apparently broken at times when storm waves or spring high tides bring water sweeping across it. Small boats can land readily on the south or seaward side when winds are not strong from the southeast.

Arno Islet has comparatively great width for atoll land areas, and the interior of the wide portion has become overgrown. Weed tree species or coconut jungles are virtually impenetrable in small sections. Numerous former taro pits in the central portion have been abandoned to become pandanus swamps. Domestic pigs have been allowed to run wild and find many coverts and thickets in which to hide. Large numbers of breadfruit trees grow on the island, together with plentiful pandanus and banana trees. Residences are widely separated for the most part.

Ebon Atoll

Ebon Islet is the largest and widest islet on the reef and compares with Arno Islet on Arno Atoll in width but is much longer; the northwestern five miles or so is mostly narrow, 50-150 feet in the middle part and widening to about 500 feet in the northeastern tip. The seaward beach is a very firm,

sand to gravelly sand beach for much of its length, possibly with hard rock underlying it. Except for the village area in the wide part of the islet, the lagoon side northeastward is not sandy but has a rocky to gravelly beach with extensive rock flats exposed at low tide. The reef flat on the ocean side is rather smooth with few loose rocks and boulders. Erosional remnants of former islet bedrock are revealed in the northeast central sector of the islet by a series of jaggedly eroded rock platforms 10 to 20 feet wide and up to 30-40 feet long. These are spaced in a line of half a mile or more flanking the lagoon rock flat about 100-400 feet off the present lagoon shore and above tide water. They lead me to believe that once the islet here was up to 500 feet wide instead of the present 100-feet. The erosion that has taken place has been largely on the lagoon side where the present hard rock flat now stands. In the extreme northeast part of the lagoon, an amazingly flat limestone reef bare at low water is almost smooth enough for roller skating. The jagged remnants above the reef flat support a good growth of Pemphis acidula, with roots anchored in erosional pockets containing some sand and holding fresh water after rains. These remnants rise $4\frac{1}{2}$ feet above the surface of the reef flat. These erosional remnants are similar to eroded bedrock in other areas, in the sharp and jagged character of the surface, which type of surface appears to occur most often where rain water dissolution rather than wave action is the disintegrating factor involved.

A pace measurement of Ebon Islet at the new church, in a line running from ocean side to lagoon side, showed a width of 600 feet. The wide part must be four or five times this width. A 50-60 foot strip bordering the ocean side stands as a relatively high beach rampart from which the land slopes inward toward a central trough which in places reaches within a foot of the fresh-water-lens surface, as revealed in dug wells and in taro pits. Roads 6 feet wide border the residential and wide part of the islet, 50 feet from the ocean beach and 150 feet from the lagoon beach.

Vegetationally, Ebon Islet is one of the richest seen in the Marshalls. Here are the most numerous lime, banana, breadfruit, and papaya trees as well as numerous pandanus trees. Most of the islet is kept well cleared of undergrowth, so that coconuts may be gathered easily. In the central parts of the wide section, however, vegetation has been left to grow unchecked, with a dense cover of all types of characteristic atoll trees in almost jungle-like masses amidst which are nearly concealed taro pits which are poorly maintained, overcrowded with ferns and grasses and unlike the neatly weeded taro beds of Mokil, Pingelap and Kapingamarangi in the Eastern Carolines. This greater carelessness may be due to the fact that men in the Marshalls have the job of farming whereas in the other areas women do the taro-pit work and own the taro patches; at least this is the case in Kapingamarangi. Morinda, Hibiscus and even Guetarda crowd the central portions of the islet together with Pandanus and occasional breadfruit trees. In this central overgrown section, however, coconut trees are dead and decapitated or old and in poor condition and are few and scattered. I was informed that coconut trees did not grow well here.

Possibly this condition may be related to the existence here of too high a concentration of phosphate; for the Japanese dug and exported a phosphate rock from here, some piles of which remain heaped-up next to the lagoonside road from the war period. The neglect of this interior area also may be related to the richness of food production on the islet and the relative sparseness of population for so large an area. Certainly the houses and yards show an evidence of care and prosperity not seen elsewhere in the Marshalls except at Ailinglaplap, or possibly at Likiep.

On the northeast part of the islet where the width reaches about 500 feet, coconut trees are tall and crowded, but the undergrowth is kept down to low weeds and ferns of which there are plenty. The weeds here are Vigna marina and Wedelia biflora, with some Guettarda and Pandanus here and there. The ground often is almost bare of weeds where a cobbly surface prevails. Even in some of the narrower parts, scarcely 50-60 feet wide, some breadfruit trees grow, possibly because the alignment of the islet here with the wind direction reduces the ingress of salt spray.

The amazing ability of coconut trees to gain a footing in the most barren situations is revealed by the five adult palms, plus a small pandanus and one young coconut tree growing on Nakor Islet separated by a channel from the northeastern end of Ebon Islet. Nakor comprises a small sand patch 10 feet by 20 feet on top of bare rock washed by salt water at high tide. Apparently the sand cover of 1-2 feet depth plus pockets holding fresh water in the rock after rainfall supplies the moisture needed by the plants.

On the southwest end of Ebon Islet just beyond the last residence house a tongue of sand stretches in an arch toward the lagoon. On this, pioneer seedlings include Calophyllum, Messerschmidia, Scaevola, Pandanus, coconut, Wedelia, Cassytha, and several grasses.

Breadfruit trees on Ebon for the most part are of a low variety and not exceeding about 60 feet height. A specimen of kirak or kurak (Inocarpus fagiferus?) observed was about 60 feet tall and had somewhat yellowed leaves.

Southwest of Ebon Islet are two islets close together connected by a ridge of sand where spring high tide probably washes through. The one nearest Ebon Islet is Enearmi, meaning "island of people", about 600 feet wide and somewhat longer. The other islet is narrower and about the same length. About half of the former on the ocean side which is lee to the wind is covered with loose coral blocks providing an unstable foothold. Apparently the ground underneath comprises materials holding a fresh water lens however, since the area is richly productive both of coconuts and of tall large breadfruit trees with trunks up to five feet diameter. Black humus was observed in parts where the surface was cleared of coral blocks. The ground is heaped everywhere with piles of moulding coconut husks and fallen fronds and is poorly cleared. The leeward half facing the pass in to the atoll is high with boulders, and slopes to a low elevation toward the center. The coral blocks give the impression of having been pushed inland, possibly during a single typhoon, and their rough shapes contrast with the smoother sand and wave washed cobbles and

gravels forming the modern beach. Everywhere Asplenium nidus and Nephrolepis grow upon the ground, stumps and coconut trees. Morinda citrifolia is a common understory tree. A small plant observed was called rebijreka (probably Peperomia in this habitat) meaning "to hold to the rock."

The reef flat oceanward has a bumpy looking surface with imbedded clams about three inches in diameter. Apparently owing to rather strong winds and waves during the previous night, large quantities of branching antler corals from the lagoon had been washed up onto the shallow parts of the reef flat in the inter-islet channels southwest of Ebon Islet and adjacent to the ship pass, there to die and rot. Tide pools with only an inch or two of water at low tide contained several types of corals, including one with light blue tips and clustered branch effect, a massive dark-blue, flat, fingered type, and the massive brain coral and "micro-atolls" with all but the outer ring dead, usually of an orange purplish color in the live fringe.

Culturally speaking religion plays an important part here as elsewhere in the Marshalls, most of the population of about 800 being Protestant. There are two Protestant churches, one a wooden structure with tin roof and the other, a mile down the other end of the settlement to the southwest, a thatched roof building. Adjacent to the latter is a large new concrete church being built (has been under construction for three years, but lack of concrete blocks stalled completion) which is to be finished for the centennial in 1957 of the entry of Christianity to Ebon and the Marshalls. In the religious homes Protestant families have prayers and hymns at evening and before breakfast, while on Sunday church services in the morning from 10-12 (the first hour for general church, the second for Sunday School) and Christian Endeavor in the afternoon fill the time. No work is done. Special services also are held at the first of the month, and there are prayer meetings during the week, usually on Wednesday.

The two houses of the magistrate's family and relatives each had a phonograph with records of religious, hillbilly, Japanese and cowboy songs. The magistrate informed me that there were four or five battery-operated radio receivers on the Islet which got news and music from Majuro and Kwajalein broadcasting stations. He was informed of the arrival of our schooner before it was sighted. A pool "hall" for billiards is the most popular resort of the atoll sports, and this is a common feature on other Marshall atolls as well, some having more than one billiard table. The job of children here is to pick up all leaves of breadfruit and other trees in the residential yard every morning and remove them or pile them up away from the yard, as observed at Kapingamarangi: in contrast to the latter atoll where women do all the cooking, and associated activities, I saw a man grating coconuts, sitting in a cookhouse with the women. Raw fish here as elsewhere in the Marshalls is often eaten as soon as caught, and the internal organs appear to be especially prized. Children catching small fish bite open the stomachs and eat the flesh, prying into the innards with fingers and licking them as an American child would clean a cake-mixing bowl.

A curious decorative emblem observed set in embossed concrete over the new church windows is a star inside a crescent, but with no known relation to a Moslem origin.

Unfortunately, less care is exercised toward the public school building and desks, chairs and books. The latter were scattered about hither and yon, amid other debris, and a few books lay open on the damp floor of concrete including three copies of a book entitled: "The Wonderful World of Science" about third grade level, and three copies of a song book entitled "New Music Horizons."

The old pastor here is by name Tokeak, two of the deacons are Jokiarik and Langwor. The latter is the adopted father of Nashon the 21 year-old magistrate who speaks a fair English and who entertained me hospitably for four days at his father's house.

Walter Milne, representing his brother, James Milne, who owns the schooner Raete on which I traveled, traveled himself with the schooner, but hired a Marshallese for captain. Walter who had been put up by Ebon people when his house was demolished by bombing or shelling during World War II, paid off his longstanding obligations socially by throwing a big party for his wartime hosts on the schooner, sailing around in the lagoon and feeding his hosts and friends there; this being the express purpose of the trip to Ebon. He also brought them numerous presents.

On the schooner I observed several pillows used by the Marshallese with pillow cases embroidered with such slogans as "God bless you, my dear," "May all your dreams come true," and "Sleep with God's love."

Jaluit Atoll

Jabwor is that section of the series of connected former islets known as Jaluit that lies at the extreme northern end of the series and adjacent to one of the deep water passes, north of which, about a quarter of a mile distant, lies Enibor, another series of connected islets. The connection in each case is a sea-wall-protected causeway constructed by the Japanese to link the concrete forts and bunkers and gun emplacements. A handcart railroad is said to have run along the causeway. At numerous points the remains of forts, bunkers and heavy guns as well as shell cases, still stand. The seawall is generally about a foot thick, of reinforced concrete, broken by storm waves in places. The causeway sectors of the long islets resulting from the connections are often not more than 15-25 feet wide, with only Pandanus, Pemphis acidula and Messerschmidia as well as Scaevola tree growth, although various vines and weeds overgrow much of the ground. Many introduced decorative trees are found on Jabwor itself, which is the widest part of the islet of Jaluit. Few coconut palms remain here, although some young trees now five or six years old have been planted. The main growths since the end of the war have been Pandanus and numerous weeds. Many concrete platforms mark the location of former Japanese houses destroyed by bombs and shells during World War II; some are being utilized for new construction foundations for the Trust Territory's agricultural station at the tip of the islet adjacent to the pass, and for the settlement of laborers and the Protestant and Catholic missions and schools now being built up. Here is a good anchorage and a concrete pier in somewhat dilapidated condition. The southern part of the

settlement has an area set aside for the Kili people to use as a base for fishing and for warehouse and communication purposes.

Immediately south of the Kili sector the islet narrows to about 20 feet width and continues southwestward in varying and generally narrow widths until another former islet of some width is reached about three miles away. Here is a former pier and two 300-foot (?) high steel towers, one on the lagoon side and one on the seaside built by the Japanese for communications. The seaside tower is badly rusted through and unusable; the lagoonside tower is comparatively intact, and I climbed the ladder to the top for photos. The remains of large buildings lie adjacent to the towers, their concrete walls are still standing and possibly usable, if roofed over. Breadfruit trees in some number occur here as well as a dense growth of other trees. Little if any attempt has been made to clear the undergrowth that has sprouted up here since the end of the war.

Northward and across the channel from Jabwor, the islet of Enibor quickly narrows after an initial width allowing breadfruit tree growth and continues in 20-50 feet width for many miles interrupted now and again by gun emplacements and corroded guns and fallen-in-bunkers of concrete and coral rock. Over all these grow a "jungle" of atoll trees, shrubs and vines. Numerous crabs and an occasional brown rat rustled in the ground debris while lovely white fairy terns, white-capped grey noddy and now and then a reef heron flew overhead. The coconut trees growing here are all young. Much Pandanus has covered the area, with Messerschmidia and Scaevola prevalent on the seaward side, as well as occasional Pemphis acidula; Guettarda is more prevalent on the lagoonside or the interior. At one point on the seaward side were several large boulders torn from the reef edge and measuring about 6 feet cubed, having been pushed by storm waves to within 20 feet of the beach edge and 150 feet from the reef edge.

Imroj Islet next to an eastern deep pass of the atoll has a reported 300 people. The settlement looks rather shabby, but the islet appears productive. A striking amount of pandanus, bananas, and some lime trees grow on it. Breadfruit trees are low but numerous. Many squash or pumpkin vines were seen in blossom and appeared to be flourishing. On the northern end is a salt water basin fed by underground tidal flow in which mangrove thrives. A large but dilapidated Protestant church is a prominent landmark. Some Catholic converts also live here, including Jobjabot who sailed as crew member of Father Donohue's St. Joseph during my trip. The magistrate was absent, and a man named Karen took it upon himself to show me the courtesies of the place.

Kili Island

This lagoonless island is surrounded by a reef of rather narrow dimensions especially restricted on the leeward side. It is backed on this side by a sand beach in the southwest sector where small boat landings can be made through a 20-foot-wide channel at low tide. At high tide such landings are made with care directly on the rocky and bouldery shore. A high bouldery and rocky beach occupies most of the rest of the shoreline except a stretch

fronting the north end of the islet where sand again occurs. Salt water enters through coarse boulders into a brackish pond on the leeward side surrounded by a growth of Pemphis acidula which here also grows on the boulder rampart running inward from the beach. A fresh water swamp now planted partly in taro occupies the central part of the islet in back of the village proper. The highest point of land is occupied by the neatly thatched little church. The wooden houses furnished by the American authorities are not in very good condition and are ugly shacks at worst.

The islet has a high vegetation and is endowed with abundant rainfall as indicated by the damp soil and moulding piles of husks. It reminded me of Ringutoru Islet in Kapingamarangi, with a flourishing growth of Asplenium nidus and Nephrolepis hirsutula standing up to six feet high in the northern end where coconut trees also have been allowed to grow and sprout crowded together far too densely for good production. Small delicate mushrooms were observed, similar to those seen at Likiep and Jaluit. Moss covers the paths as at Nukuoro Atoll. The taro swamp, however, is badly tended, and overgrown with 2-3 feet tall grass and ferns. Much of the swamp is still unplanted and lying in waste and weeds.

In the swamp there was a large growth of a woody stemmed weed called mer (Jussiaea suffruticosa) by my guide. It has small yellow four-petaled flowers.

On the sandy leeward beach-ridge grows several kōno trees (Cordia subcordata) one of which is 6 feet in diameter one foot from the ground, but branches thereafter into limbs of about one foot diameter each. A Morinda citrifolia was seen with a trunk diameter of about one foot.

Some of the Kili people complain about not enough food and not enough variety of food, but there appear to be numerous breadfruit and a fair number of banana trees as well as coconut trees and some pandanus. Some 10,000 taro plants were brought in for them to plant, but the people are unused to its culture and apparently do not particularly like to work in the taro fields. They ate up the taro, often without replanting the tops, so that the stock is much reduced. While 210 or so people in 1956 may be rather too many for so small an area, food production from the land probably is greater than that from their erstwhile Bikini homeland, although they miss the rich lagoon fishing area. They appear not to be working too hard at improving their plant production, however.

Fishing is either on the narrow reef at high tide, or in the open ocean where it is restricted to the leeward side not far from shore. Five or six outriggers were used in line fishing and a dozen men and boys were standing on the reef at high tide using goggles and spears for fish and mollusks. Before our schooner left about a dozen fish 7-9 inches long were bought or exchanged by our schooner's owner from the Kili people. The Kili store was the best stocked seen on the outlying atolls during our trip, although this does not indicate the buying power of the Kili people.

Kwajelein Atoll

The islets visited on Kwajelein had been violently disturbed by war activities and the vegetation was thus quite abnormal. The islets visited included five north of Kwajelein, of which Ebeje (commonly known as Ebeye owing to American usage) is the only one with a settlement, except for the one family living on South Loe Islet next northward of Ebeye. Northward of South Loe are North Loe, Bijinkur, and Eboj. Most of the latter three are under 100 feet wide, although Eboj is quite long. Scaevola is the dominant vegetation throughout Eboj, although Ipomoea pes-caprae forms a creeper mat in large areas. A few scattered Messerschmidia and a few Pandanus occur, with a few coconut trees here and there. Triumfetta procumbens also was prevalent in places and flourished better in the shade of Scaevola than in the hot sun adjacent, or, at least, showed larger leaves of greener hue, although having fewer blossoms in the shade.

North Loe was overrun with Wedelia biflora and Vigna marina in much the same way that Ebeje is. A few Guettarda trees occur and Messerschmidia is rather common here. Pemphis was not seen here, but my informant said that it was common on the small uninhabited islets of the atoll. Its hard-wearing wood is used for husking sticks, for making canoe keels, and in the olden days, for spears.

Kwajelein Islet is just a large airfield with a military settlement and facilities. The Navy has a daily ferry service between Ebeye and Kwajelein Islets to take the Marshallese employees back and forth. Ebeye is a village of over a thousand Marshallese from many atolls who work for the Navy for their existence for the most part. On the islet is a Coast Guard Loran station (this operates a radio guiding system for ships), the Kwajalein Island Trading Company (Kitco), the Marshalls Import and Export Company (Mieco), a few small stores with pool tables, and the offices and residences of the Trust Territory Administrator. The latter is in the process of constructing new quarters but in the meantime lives in an old "temporary" housing unit left over from the war period. However, the Coast Guard sells them electric power for light, deep freeze and refrigerator, and they have a running water system derived from an elevated tank into which water is pumped from a concrete cistern collecting rainwater. Four or five small rooms in a building next to theirs serve as hostel accommodation for visitors.

Ebeye is depressing from a vegetation standpoint. Aside from a couple of small clumps of coconuts and a scattering of Messerschmidia, most of the vegetation comprises a half dozen varieties of weeds.

Likiep Atoll

The two chief residential islets lie at opposite ends of the long lagoon some twenty miles apart. Of these the most important by far is Likiep Islet and village on the east end. There also are a few residents in the other larger islets scattered along the reef. The shape of Likiep Islet is like that of a fishhook without the barb, the sharply curved part being in the eastern end, so that an excellent sheltered harbor is formed with sandy bottom

that is deep enough to accommodate the larger vessels that visit the atoll. The village is around this section of the harbor. At the end of the hook sand has been accumulating consistently, for a long period, and extending the shore line into the lagoon. A pier situated here now has its face 20-30 feet from the deep water that formerly was alongside, so a new pier extension has been built into the lagoon. Capelle DeBrum, one of the two leading men of the atoll, stated that so far as he had observed, no noticeable erosion of a serious sort had made inroads upon the land area of the islet from the oceanside.

The islet is not more than 300-500 feet wide being narrowest in the western end. Scaevola and Messerschmidia and some Pemphis cover the entire seaward strip for a depth of 20-50 feet. This has been left as a shelter belt intentionally to afford the coconut trees protection from the salt spray. The lagoon-side has been entirely cleared of weed species, and coconut trees grow right up to the edge of the beach. Breadfruit trees are abundant on the village end where the breadth of the islet is greatest. None appear more than 40-50 feet high and they are much branched close to the ground. The rest of the island is generally well planted to well spaced coconut trees, with occasional Pandanus and more rarely Calophyllum as an understory, although the latter are left as shade trees on the beach next to the village. The ground-cover is mostly grasses, some foot-high succulent weeds, entangled in some areas with Cassytha filiformis, the whole topped by a rather dense growth of arrowroot used here for food as elsewhere in the northern Marshalls after the breadfruit season, together with the pandanus which then comes into production more abundantly.

A striking topographical feature on Likiep Islet are the many large depressions on the western half of the islet, some round, some elongated, but with no special directional alignment. They reach down approximately to the surface of ground water. Several have been planted to taro, but some have coconut trees growing in them. An old man of 70 when asked about them said that he had heard that they had been caused by storms in ancient times, but he did not know how they originated. This appeared to be the opinion of other older men who did not believe they were dug for taro pits although some have been used for this. Today there is only a small amount of taro grown at Likiep. My opinion is that they were man-made taro pits dug before memory of the present people.

Major storms have come from the southwest and northwest. The last major storm was in 1918 when some 5,000 coconut trees were knocked over, but it was not a severe storm. There was no serious land erosion, although in several places on the lagoon side, accretion of land has taken place owing to sand accumulation. Water supply generally is plentiful, although occasional low periods occur when no rain falls in 3-4 months.

A localized growth of Wedelia biflora occurs on two sides of the path near the middle of the islet. Numerous patches of sandbur grass also bordered the path. The general aspect of the coconut plantation is very clean; all leaves and husks are piled up and burned. This injures some of the coconut tree trunks.

There are three varieties of breadfruit, moderately high yielding, with the producing season being from May to August; some production occurs in February.

The pandanus seasons are January to May and August to December, i.e., from August to May, thus taking the people through the period when breadfruit is not in season. Arrowroot (Tacca) is not planted but grows abundantly by itself. Food supplies are lowest in September.

Most of the coconut trees here date back to German planting by the ancestors of the present land-owners; a few were planted during the Japanese times. Two varieties of taro-plants grow here: Iraj (Cyrtosperma chamissonis) a large variety, and kotak (Colocasia esculenta) the true taro. Each family has a pig or two and a few chickens. Marbele (Ipomoea tuba) a vine, is fed to pigs. It has a white morning-glory type flower. Plumeria and Bougainvillea have been introduced as ornamentals. The outside fiber of Triumfetta procumbens is used for handicraft weaving, Pemphis wood for furniture and canoe keels, Morinda fruit for pig feed, and Calophyllum for boat keels and other parts having hard wear.

Some 3 or 4 poisonous varieties of fish, which everyone recognizes, occur in the lagoon or on the reef. Capelle reported that on Majuro a type of fish which had regularly been eaten for years had, about two years ago, suddenly become poisonous.

The wooden house with the tin roof is preferred here, particularly because it is used for water catchment and provides water much cleaner than that washed down from thatch with the latter's accumulation of insects, skinks, lizards, etc. Wood had been easy to get from salvage and scrap at Kwajelein after the war, but is now growing scarce. For a time it had been free for anyone to take.

Likiep has no large breadfruit trees suitable for canoe dugouts; formerly canoes were made from driftlogs, but in recent years driftlogs have grown quite scarce (possibly owing to change in lumbering or rafting operations in the northwest of the U. S.). During German times there had still been some sea-going canoes, but western type boats were built and used for inter-atoll travel. Now canoes are all too small for this, and they also are rather few in number. During Japanese times, a large steamer visited the atolls once every two months, while smaller schooners made trips to each atoll once a month or oftener. Likiep has two locally owned schooners that operate between here and Kwajelein or Majuro. Transportation for Likiep, thus, is not a serious problem.

In June 1956 some 518 people were resident upon the atoll, most of them on Likiep Islet. About two-thirds of the local population is Protestant, and perhaps one-third is Catholic. The former have a large but unpretentious church whose pastor is Koneaea. The Catholic church is new, with a new rectory, nuns' house and school, all in bright aluminum and neatly laid out. The resident American priest is presently Father McCarthy whose schooner ran

on the reef at Kwajelein not long ago because the pilot and passengers were all asleep. His engine was rescued, but the hull was abandoned. Likiep is the center for Catholic girls' education in the Marshalls.

Before German times Likiep was temporarily uninhabited, but was visited by Wotje people from time to time for fishing, turtle and bird catching or for wood supplies. In the 1870's four men, an American, an Englishman, a German and a Portuguese combined their resources and bought the atoll from the Wotje chief who owned it. Actually, by tribal custom he did not have the right to alienate the land. A few years later, the American and Englishman sold out to the remaining partners and the atoll became the property of the Capelle and DeBrum families whose descendants remain the owners. It was not until then that coconut plantations were laid out, the owners hiring laborers from other atolls to come to Likiep to work for them. The latter eventually settled permanently as laboring families on the atoll and lost their outside connections as far as land rights elsewhere were concerned. Now these laboring families have been resident some 70 years and have nowhere else to go. They have no legal rights to local land, however, and work the plantations on a share-crop basis for the land-owners. The latter consist of the two clans, the Capelle with eight families, and the DeBrum with nine families. The original owners intermarried with Marshallese and subsequently with each other.

Capelle DeBrum is now recognized as head of the combined clans, while Melander DeBrum, his brother, is next in rank, and the two are at the top of the social and political hierarchy. Only one of the landowning families, Raymond DeBrum, is Protestant, the rest being Catholic, while most of the laboring families are Protestant. The economic conflict that has occurred between the landed and the landless is thus sharpened by religious division. Some of the landless recently have tried to make claim for property rights in land but have been unsuccessful. Dissatisfaction with earlier agreements for crop division recently brought on discontinuance of copra making work by many of the laborers, apparently supported by Raymond DeBrum, but the present arrangement of a 50-50 split of copra proceeds appears to have satisfied most of the laborers. Perhaps 25 per cent of them still are disgruntled and are not too active in producing copra.

A serious pest affecting breadfruit has been recently noticed (about a year or so ago). It turns breadfruit blackish-brown, spreading from an infected spot to the entire fruit which then becomes rotten. It was noticed first on one tree at the south end of the village, but this summer infestation was noted on several other trees, including one at the other end of the village. Small fruit flies fluttered about the rotten or diseased fruit, but these may be attracted by the spoiled fruit rather than by the disease carrier. Capelle expressed worry that their spread to all the trees would ruin this important food source for Likiep.

Lodo Islet is a quarter of a mile northward across the channel from Likiep village. Its aspect is similar to the plantation area of Likiep Islet. It is well cleared of undergrowth up to the shelter belt on the oceanside where a considerable growth of Wedelia biflora occurs. Attempts

have been made to burn it. In other areas the ground cover is much thinner than on Likiep Islet, reflecting a drier soil. Grass intertwined with Cassytha filiformis makes a thin mat. Six or seven houses are scattered along the lagoon side on the wider east end of the islet. Maas Hone, who recently completed his first year at the University of Hawaii, is the alab or head landowner of the islet, succeeding his father who died this spring.

On the west end of Lodo in the inter-islet channel the beach rock rises out of deep water in a coral cliff. A great slab had broken off due to erosion and undermining.

On walking along the lagoon shore with me, Maas noticed dense schools of small fish, sardine-like and 7-8 inches long. He got a throw net and, trailing the schools from shore, made a catch of about 150 fish after about 40 minutes and half a dozen throws of the net.

Maas informed me that there was at least one islet of small size along the reef that was covered with a tree whose description points to Pisonia. It was an islet with many nesting birds. In traveling westward close to the lagoonside on the schooner, I observed an islet with vegetation that appeared to correspond to that of Pisonia. Many birds circled over it.

Liglao Islet at the opposite end of the lagoon from Likiep Islet has its lagoon beach facing the prevailing wind. Vessels visiting this place sail out through the adjacent pass and anchor off the oceanside reef in the lee of the wind. After Likiep Islet, Liglao has the largest number of residents. Actually, it comprises two islets close together separated by a few yards of channel. The larger one of the two, with a lagoonside beach is called Imejwa; the smaller is Maat. It took me about three hours of steady walking to encircle Imejwa. A remarkable and high sand beach with a crest 12 feet above high tide slants at a 30-40 degree angle to the water. From the crest there is a slightly sloping backshore which sometimes turns into a number of low dunes reaching inward 75-100 feet from the southeast end of the islet around to and along the east side.

The seaward side to the lee of the wind has a pronounced beachrock development in several well-marked strata sloping at 15-25 degrees dip. The channel to the north of the islet has what appeared to be raised bedrock in spectacular formations. They probably represent the remnants of islets formerly covered with soil now destroyed by storm action.

Along the sandy beach crest of the lagoon side and on the southeast end Scaevola is the dominant cover, with Cassytha throttling much of it. By contrast the northwest channel side and the ocean side find Pemphis forming a spray-burned and impenetrable shelter belt. The crowns of some of these show distinct alignments controlled by wind and spray.

The westward coast of the islet has sharply eroded bedrock standing several feet above the main reef flat. At the reef's edge here the lithothamnion ridges have a beautiful pink color, but this disappears in the leeward part of the reef.

The southeast sections of the islet are park-like and well-cleared. However, everywhere thousands of coconuts litter the ground, many well sprouted with half a year's growth, indicating the neglect that the laborers' dispute with the landowners has brought about. At the northwest sectors of the islet, neglect has permitted a rank growth of sprouting coconut trees 6-10 feet high, intermingled with Pandanus trees. The ground is heavily littered with leaf and debris among the young growth, so in places one finds the thickets impenetrable.

Majuro Atoll

Majuro is quite a large atoll, about 30 miles or so long - with numerous islets - including a large one, Majuro Islet about 4 square miles in area.

Uliga at the opposite end of the atoll from Majuro and where the Trust Territory District Administration is centered is unrepresentative but still exemplifies an essential part of the Marshalls' economic and social transformation and acculturation processes. Here an airfield with weekly connections by Trust Territory plane and occasional Navy plane, a motor road system, trucks and jeeps, wharf and terminal warehouses for ocean freighters, electric lights, hospital with medical and dental services, and more and better commodities at Kitco and Mieco, as well as a commissary with all essential foodstuffs, and a regularly paid staff, with money and things to be purchased, all occur. Here is the seat of overall government as well as the center of inter-island political relations and the site of the Marshallese Congress.

War damage to vegetation is apparent in the lack of well planted coconut plantations and in the overgrowth of weeds. Part of this is due to the fact that some land has been retained by the Trust Territory Administration, but is not being immediately used by it. Only when one gets away from this center does the vegetation situation become more normal in the sense of native plantations, as in the case of Enegu Islet, about three islets east of the pass, on the north reef. However, even here the situation appears affected by the nearness to the administration center of wage-paid labor, where cash is abundant enough so that urgency in working copra may not be pressing. Or, possibly, the owner of a large section of this islet lives far across the lagoon and seldom gets to Enegu to work his copra. The eastern two-thirds of the islet are overgrown with weeds and have sprouted coconuts strewn over the ground, the stage of growth of the latter indicating many months, possibly a year, of neglect, with sprouted nuts having fronds up to five feet or more in height.

On the west end of Enegu, a residential owner lived in an area newly planted with neatly rows of coconut trees about three years old. Immediately after the war or during the war, the area had been cleared for use by the Coast Guard according to my informant. This explained the uncrowded vegetation and new coconut plantations in straight rows as advised by the American agricultural aide.

Bananas and papayas are plentiful on this atoll, as is breadfruit. Taro is mostly lacking, however, and the people prefer to buy rice and flour as staple substitutes.

Maloelap Atoll

Airik and adjacent Makaru Islets on this atoll were visited by the writer in a Navy plane that landed in the lagoon. The former is the main residential islet of the atoll. The other islets in the atoll were heavily damaged by the war, as they were used by the Japanese for an air base and numerous installations and buildings with concrete platforms that have obstructed the replanting of the area with coconut or other fruitful trees. Wrecked planes and equipment and buried ammunition, unexploded shells and mines still cause the people to be fearful about clearing land and cultivating. Only recently a shell exploded without being touched or moved, and six ammo dumps or shells and a mine were exploded by a Navy demolition team sent there in July of this year. Such areas are overgrown with weeds and weed trees of many years growth, so that clearing them will involve much labor.

Airik Islet or Village appeared to be plentifully planted with productive breadfruit, pandanus and coconut. The breadfruit trees, however, are low, under 40 feet, as at Likiep. The islet is wide, about 1200 feet in sectors near the northern end. About 200 feet of this width on the ocean side, however, has been left as a shelter belt in which a rare pure strand of Barringtonia was observed, a stand about 150 feet across, a rather unusual feature on atolls. No taro pits are planted to taro, but old pits contain banana plants. No Pemphis or Suriana were seen on the ocean side, Scaevola being the predominant shelter belt tree, plus a few Pandanus and Guettarda and another shrub resembling Scaevola.

On Makaru Islet only the lagoonward third appeared to be cleared and with coconut uncrowded by weed trees, the oceanward two-thirds being a jungle of undergrowth including numerous young coconut sprouts surrounding the adult palms.

As seen from the airplane pink algae appear to cover the windward seaward reef-edge.

Mejit Island

Mejit is a relatively large island as islets on reefs go. It has two sections once separated by a narrow channel, but no separate names were attached to them. The larger section which has the greatest breadth was known as the "main island," the other section was merely called "that island" or "the other part." The channel appears to have been no more than 100 feet wide or less at the ocean side, broadening to 400 feet or more towards the lagoon side. There also appeared to have been an inlet or tongue of the "lagoon" into "that island." on the lagoon side which now constitutes a salt lake with a marshy fringe. The formation of this appears to have occurred during Japanese occupation times when the channel gradually filled in with

sand pushed in by the tide from the "lagoon side," so that now there is a broad sandy connection between the two parts, making the whole a single island surrounded by a reef. On the leeward side of the island is a narrow shallow "lagoon" hardly more than 150 yards wide and stretching along much of the leeward side. At low tide, it takes only about ten minutes to walk from the village along the almost exposed reef to the ocean edge of the reef.

The leeward beach is of fine sand and unusually high, appearing 15-20 feet from low water to beach crest. The southwest beach also is sandy but much lower. The vegetated area here runs inward from the beach crest in a sandy strip 250 feet wide; then the land suddenly rises 5-6 feet in elevation in a line roughly SE to NW.

The vegetation reflects the low rainfall and is similar to that found on the islets of Likiep, Utirik, and Ailuk. Breadfruit trees are low, but appear to do well and are productive. There are numerous papaya trees and some banana trees. The undergrowth below the coconut trees characteristically is a mixture of various grasses and rather dense stands of arrowroot (Tacca), with few weed-tree or bush species, although Pandanus trees are numerous. The aspect is park-like, and it is easy to walk in any direction across the island. On the east-southeast side a gradual rise occurs about 200 feet from the beach ridge. Ipomoea tuba, a morning-glory type vine, without flowers at the time of observation, forms a dense ground cover in places in the interior. Scaevola and Messerschmidia form a shelter belt on the ocean side here, followed on the inward part by a zone of Pandanus 20-30 feet wide. Inward from the east beach Cassytha filiformis forms a dense ground cover together with Lepturus and other grasses for a width inland of over 250 feet. Roads 6-7 feet wide, bordered with a line of coral stones, extend through the village and around the main islet, as well as through sections of the adjoining "that island." Many of these roads are overgrown with low weeds and grasses, however. 600 feet inland from the east shore Ipomoea tuba so covers the ground to a height of several feet as to constitute a serious impediment to walking. Here also are found some Morinda bushes of small size. Another 100 feet westward and inward and not far from the village are numerous taro pits, some well weeded and with a water-filled "drainage" ditch around the edge of the pit; others abandoned and not in use for taro. Breadfruit trees on the banks of these pits are scrawny and small, with trunks of under 1-2 feet diameter and with the main trunks generally broken off and rotten after reaching a height of 20-30 feet. Pandanus trees are also rather low, but are numerous on the half of the islet occupied by the village.

The old channel and part of the inlet that now has become filled with sand have been planted during the last two to five years with coconut trees, most of which are doing rather poorly, appearing chlorotic. The lagoonward or, rather, leeward part of "that island" also has a soil of nearly pure sand on which the coconut trees are low, chlorotic and often dead. In sections of the filled-in channel now planted with coconut trees, there still remain numerous clumps of Pemphis acidula to show that this once stood in salt water. Doubtless underlying the sand around the Pemphis there is solid rock commonly found associated with this tree or bush. Bruguiera type mangrove trees line the edges of the salt pond and are backed by Pemphis. Only this one species of mangrove was noticed.

One species of bush which was very common in parts of the interior was a low growing type called ulej by the inhabitants (Clerodendrum inerme). It has a white flower forming an incomplete circle of petals somewhat like those of the Scaevola. A similar plant, also called ulej (Pseuderanthemum carruthersii), is sometimes used for hedges around residence lots.

Flies were numerous and annoying; small swarms of them followed one even on the breezy windward side beach.

Namu Atoll

Our schooner made a landing on the leeward lagoon shore of Mai Islet of Namu Atoll. This islet showed an obvious change to a wetter climate in comparison with Maloelap. Mai is in the southeast end of the atoll. Coconut trees here are very tall and old, and the soil appeared black with humus and fertile. Breadfruit trees grew more than 90 feet tall, one was seen to be five feet in diameter at waist level.

The interior of the islet has a low swampy trough parallel to the shore. Coconuts sprouting 12-15 feet apart resulted in some crowding. Wedelia biflora weeds were rampant over much of the land. The soil surface was bouldery, with coconut fronds left about in disorder to rot. Morinda is a common understory tree with some Guettarda. Ipomea tuba grew on parts of the windward beach. On the southeast channel beach on the windward side of Mai grew some spray-burnt shrubs resembling Scaevola called ikung (Terminalia samoensis) by my informant. The burning method of clearing the underbrush had damaged some coconut trees in this part of the islet. A small pit with swamp taro was observed, the edges planted with banana trees. Only the single leaf type of fern (Polypodium scolopendria?) seen at Likiep was observed here, no Asplenium nidus and no Nephrolepis that characterize the wetter parts of the Marshalls. Prevalent weeds were Triumfetta procumbens, and a plant called kuli (Sophora tomentosa); a glossy-leaved tree called gizet and Bruguiera conjugata (called dzong) were observed.

The lagoon beach was clear of large trees and coconut trees for a distance of 20 feet back of the beach crest, and the sand was sparsely covered with grass and seedlings of Scaevola and Messerschmidia, indicating recent sand accretion.

The characteristic habit of Pandanus of sending aerial prop roots down from even upper branches was shown by an example of such a root reaching ten feet downward from the branch.

The taro-like plant called wot (Alocasia macrorrhiza), which is not edible, grew here in large numbers under the breadfruit and coconut trees. One taro pit was seen to be overgrown with weeds, while four breadfruit trees grew on its banks, each about a foot in diameter. The pit size was only 30 by 30 feet. Pandanus is the common beach-edge shrub, but I saw no Pemphis or Suriana.

There is some beach rock exposure on the lagoon shore in the north end of Mai Islet.

Across the lagoon from Mai, our schooner anchored off the leeward ocean side of the reef. On the rock flat of the reef near the pass there stands a huge boulder that appeared 6-7 feet high and perhaps 10 by 20 feet across, that must have been torn up from the reef edge by a storm wave. Observed in passing on the leeward side of the islet was a reef whose edge was only a few yards from the shore, the boulder rampart on the islet adjacent here appeared to rise 5-6 feet higher than where the reef edge was considerably farther out from shore. In an inter-islet channel on this same leeward (westerly) side of the reef, the reef flat was mantled with large boulders 3-5 feet in diameter.

Ronlap (Rongelap) Atoll

In conversation with me on 22 June 1956 Maynard Neas, District Administrator at Majuro, described briefly the problem presented by the people of Ronlap (Rongelap) about 100 miles east of Bikini. They were victims of the fall-out of the bomb test two years ago when some of them suffered mild burns, hair fall-out, etc. As a result the people were evacuated by Navy landing craft and removed to a small islet of 16-18 acres on Majuro atoll which was administration property. Here the United States had built them a village of wooden houses (plywood) and the community as a whole was given a subsidy of \$1100 monthly.

The number of people evacuated from Ronlap included a few families in Ronrik (Rongerik) and Ailininiae (Ailinginae), which two atolls were worked as plantations by the Ronlapese who owned them and the total was only 74 people. Their atolls lie in the dry zone of the northern Marshalls and are not very productive, especially during the winter dry season. However, there are said to be five or six square miles of land above high tide altogether, and the people subsisted all right. Their settlement in Majuro with a regular cash income, however, was somewhat of a bonanza, since they had to do little for a livelihood aside from picking a few coconuts for their immediate needs, and do a bit of fishing. A few breadfruit trees also offered some variety together with some papayas. The cash income or subsidy enabled them to buy at the trading store what they needed or wanted. This attracted very soon a large number of extended family members or relatives and friends from other atolls. Now, two years later, the total population of "Ronlapese" has grown to 175 people.

The AEC has been conducting tests for lingering radio-activity from fall-out at Ronlap and the neighboring atolls, and it appears that this is largely gone, so that the Ronlapese may be returned to their atolls soon. This involves the question of rebuilding the homes on the atolls and of transporting the people there from Majuro atoll. The AEC has promised the Ronlap people that it would construct a new village for them, wooden houses similar to or better than the ones they now occupy on Majuro, and it inquired as to how many wanted to return. The Ronlapese were also informed that the subsidy would end with their return and they would again be on their own as before the tests of the bombs took place. The answer was rather surprising, since instead of a few more than the original 74 people that might be expected to want to go back, all of the 175 people now in the settlement wanted to go there. Mr. Neas thought that possibly the great attractions

were the wooden-tin-roofed houses which, although merely small one-room affairs, nevertheless provided a drier place to live and lasted a longer time without repairs than native houses. There possibly also has developed a community esprit-de-corps which may be a factor in the desire of the whole group to move there rather than for the hangers-on to disperse to their original areas of residence. Finally, there perhaps also may be some wishful thinking that in spite of the announced intention to discontinue the subsidy, the Americans might still subsidize them in some way.

Captain P. C. Staley, Commander of the Kwajelein Air Base, informed me that the problem of furnishing transportation for these people back to Ronlap had been dumped into his lap. He had not decided yet whether he would send them back by air or boat. Mr. Neas thought that the best way would be to send one or more landing craft to take the whole community at one time, as had been done when they were removed from Ronlap.

Utirik Atoll

Utirik Atoll has few islands, and they are not large. The residential islet of Utirik is the largest, possibly 2500 feet long by about the same depth, roughly triangular, but with almost a mile of attenuated strip of bare sand in addition westward.

There are several rather unusual features about this islet. Along the north side of the eastward bulge oceanward and running for about $\frac{1}{4}$ mile toward the lagoon with a width up to 100 yards, is one of the largest boulder and cobble beds and ramparts I have yet seen among the atolls. Much of it is bare, the rocks and cobbles turned black and gray with algae. Most of it, however, is covered with a wide stand of Scaevola shrubs. As the shoreline turns towards the southwest, an equally unusual sand beach and backshore development takes place, with a width of about 200 feet. This also is mostly covered with Scaevola, but with occasional Messerschmidia. On the south side of the island, where it abruptly narrows, the sand beach also narrows and is bordered by a long strip of exposed beach rock inward of which the ground has been scoured out by a typhoon which occurred, according to my informant, during pre-Japanese times, possibly the one of 1905. The beach rock extends with characteristic oceanward dip for a distance of more than a mile. Inward of it a desert-like expanse of sand and gravel stretches for a width of 500 feet and narrows as the end is approached. On the lagoon-side of this patch is a second line of beach rock, this time dipping down toward the lagoon and having a fine texture which shows clearly its origin from lagoon sand. A new ridge of sand has been built up lagoonward of this to a height of 5-6 feet and is covered with grass and occasional Scaevola. The large sand patch has scattered clumps of Pemphis, Scaevola, and Messerschmidia, and in one central spot, also half a dozen coconut trees with nuts. Most of it is bare, however. Because of the lack of cobbles and boulders in this scoured-out remnant of former vegetated land area, it can be assumed, perhaps, that the storm-wind came from the direction of the lagoon. This same wind probably accounts for the large sand beach development on the south side described above. The nature of the exposure and the position of an adjoining islet to the northeast would indicate that the storm wind probably swept across this section of the islet from a westerly direction.

A ten-feet long sawed-off section of a log three feet in diameter had drifted on to the southeastern sand beach. On it were cut the names Ole, and also Ha, and there was a blue-pencilled name, Halleck. Probably the log came from the northwest coast of the United States.

In the southwest end of the islet exposed to the sweep of the north or northeast wind from across the lagoon, the results of a second storm appear. This storm occurred in 1951, and brought the fall of 10-20 per cent of the coconut trees then standing. The trees lie fallen toward the south to southwest directions. Exposure of the roots shows the depth of the main roots to be about $2\frac{1}{2}$ feet in a smallish clump less than 3 feet in diameter, with sand as the soil constituent.

The plantation vegetation is similar to that at Mejit and Ailuk. Arrowroot (Tacca) is omnipresent and quite dense, grasses of several species together with a fair amount of Triumfetta procumbens form the ground cover. Breadfruit trees here as elsewhere in the northern Marshalls are low, mostly from 20-30 feet high, some of the young vigorous ones well rounded and forming a beautiful tree. Few had trunks over a foot in diameter. This is partly explained by the fact that perhaps many, probably most, large breadfruit trees were blown over in the 1951 storm. Some black fungus or other disease had attacked many of the leaves of some trees observed. There were some abandoned taro pits in the interior, but I was told that no taro was being grown.

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by

William H. Hatheway

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AGRICULTURAL NOTES ON THE SOUTHERN MARSHALL ISLANDS, 1952¹

by
William H. Hatheway

On Arno Atoll several instances of low productivity of coconuts were observed. The Marshallese recognize at least two types of "poor coconuts:" "laora" and "mellal." Both conditions appear to be related to local soil conditions, although many Arno people attribute "mellal" to the presence of demons. Lajibili, former magistrate of Arno, called the writer's attention to a malady affecting breadfruits. Since there appears to be no native name for this condition, the term "brown rot" is suggested. On the southern field trip of September 18-27 the occurrences of "laora" and brown rot of breadfruit were investigated. In addition, notes were made on all local agricultural problems which appeared sufficiently important to warrant attention.

Laora in its most extreme form is characterized by:

1. Yellowing and scorching of the leaves of the coconuts. The tips of the leaves and leaflets are most severely scorched. Areas adjacent to the midribs are usually green.
2. The leaflets of the coconuts are sometimes twisted and more or less knotted together.
3. Dead leaves tend to hang on the tree, giving it the appearance of a Washington palm.
4. The trunks are sometimes blackened.
5. Density of stocking is low -- about 40 trees per acre in the worst affected areas of Arno. This is about 1/3 the stocking of the more productive groves.
6. Dead trees are conspicuous. About 35 trees per acre are dead in the worst affected areas of Arno.

¹ The information recorded in the notes presented here was gathered during the brief visits to the several atolls mentioned during the official field trip of September 18-27 to the southern Marshall Islands. It was written up for the use of the District Administrator and his staff and was mimeographed for very restricted distribution to staff members. Since there appears to be no probability that the information will be worked up into any further publication, and since there are original observations, not available elsewhere, Dr. Hatheway has consented to the reproduction of his memorandum to the District Administrator for the users of the Atoll Research Bulletin. It has here been reproduced in exactly its original form, without further editing except change of title. -- Editor's note.

7. The older trees are mostly barren of fruit, although they produce inflorescences. Apparently the fruits abort at an early stage of development.
8. The younger trees bear fairly well; the water is exceptionally sweet.
9. In the worst affected areas of Arno the ground cover consists of
 - a) Clumps of Fimbristylis cymosa ("Relijman"), covering the ground between which is a leathery black blue-green alga (unidentified as yet) resembling a crustose lichen.
 - b) Tacca leontopetaloides ("Mokmok" or "Arrowroot") is common. Its leaves are yellow except along the veins and are characterized by circular brown spots 1/8 to 1/4 inch in diameter.
10. Abandoned coconut groves are invaded by the following species of plants in roughly the order listed:
 - a) Wedelia biflora ("Marjej")
 - b) Premna obtusifolia ("Kar")
 - c) Artocarpus altilis ("Breadfruit:" variety "Bukaral" most common, spreading by root suckers; variety "Mijwan" invades by seed)
 - d) Pipturus argenteus ("Arme")
 - e) Morinda citrifolia ("Nen")
 - f) Guettarda speciosa ("Wutilomar")
 - g) Allophyllus timorensis ("Kitak")
 - h) Pandanus tectorius ("Erdwan")
11. "Laora" is restricted to the centers of the wider islands. Most of this land was formerly in breadfruit forest, scattered throughout which were pits in which the Micronesian taro (Cyrtosperma chamissonis or "yaraj") was grown. Since the advent of copra culture much of this land has been given over to the growing of coconuts.

Laora is here tentatively attributed to a deficiency of available phosphorus, although the opinion of many of the more sophisticated Marshallese that it is due to a lack of salt (sodium chloride) should not be dismissed without further investigation. Phosphorus deficiency is suggested by:

 1. The analyses of Dr. E. L. Stone (Atoll Research Bulletin Nos. 5-6, November 15, 1951), who found only 10 pounds of available phosphorus per acre in a sample of soil from an area of poor coconuts on Arno Island.

This is less than 10 percent of that available in productive groves.

2. Field evidence from Ebon Atoll, where there are local phosphate deposits in the interior of Ebon Island. The coconuts on the soils on or immediately adjacent to the phosphate deposits are vigorous and bearing heavily, whereas "laora" is restricted to the non-phosphatic areas of the same island.

3. The oily nuts of the coconut contain relatively large amounts of phosphorus, as do most seeds. The abortion of the fruits at an early stage suggests a deficiency of an essential element. The sweetness of the nuts that are formed may indicate that the sugars are not transformed into proteins. Phosphorus is an essential constituent of nucleoproteins, which tend to occur in high concentrations in seeds.

4. "Laora" is restricted to certain local areas, on which other species of plants totally unrelated to the coconut -- e. g., *Tacca* -- show similar symptoms. This makes it extremely unlikely that "laora" is to be attributed to the presence of insects, nematodes, pathogenic fungi, bacteria, viruses, or other pests.

"Mellal" is easily distinguished from "laora". The symptoms are:

1. General yellowing of the leaves of the coconut. New leaves tend to remain yellow for long periods of time.

2. The coconut trees appear stunted and probably die early. Trees in "laora" areas are often very tall.

3. Dead leaves do not fall readily.

4. The trees bear only a few nuts.

5. Ground cover is invariably depauperate. It consists chiefly of an open stand of bunchy *Lepturus repens* ("ujoiij" a grass). The parasitic vine, *Cassytha filiformis* ("kanong") is usually abundant. *Intsia bijuga* ("kubuk") grows as a straggling shrub, although on better sites it becomes a tree often common.

6. The soil is a nearly unaltered gray sand containing very little organic matter. The soil of "laora" areas, on the other hand, is a black loamy sand containing as much as 30 percent organic matter.

"Mellal" was observed on several islands of Arno Atoll, usually at or near lagoon or ocean shores. Stone's analysis of a "mellal" soil suggests a nitrogen deficiency, although excessive salinity is possible in some cases. It is extremely likely that many instances of "mellal" can be traced to ancient typhoons. In the course of these large quantities of sand and rock fragments were thrown up on the land, or the topsoil was washed away. The resulting soils are immature and contain little organic matter or

available nitrogen. It is suggested that the planting of native leguminous ground-cover plants be encouraged. These would tend to build up the nitrogen and organic matter content of the soil. The plants best suited for this purpose are the creeping vines Vigna marina ("markine-jojo") and Canavalia spp. ("marlap").

"Mellal" is a common but very local condition. The affected areas are usually less than 5 acres in extent. Since it appears that intensive research into this problem by agriculturists of the Trust Territory would not yield returns commensurate with the time and money invested, no attempt was made to study the distribution of "mellal" in the southern Marshalls. "Laora," on the other hand, is a problem of major importance. Over 200 acres on Arno Island alone are in poor coconuts or secondary forest. About 60 tons of copra per year could be harvested from this area if the condition were corrected. This would increase the cash income of the atoll by about 10 percent. Moreover, the presence of a considerable source of phosphate rock at Ebon Atoll suggests that if "laora" is correctly attributed to a lack of available phosphorus, the condition might be quickly and inexpensively remedied. This would also, of course, provide income to the owners of the Ebon phosphate. The distribution of "laora" in the southern Marshalls is:

<u>Atoll</u>	<u>Islands</u>	<u>Remarks</u>
Arno	Arno	Very severe
	Ine	Slight
Majuro	Majuro*	Not seen
Ebon	Ebon	Severe
Namrik	not present	
Kili	not present	
Jaluit	Jaluit*	Not seen
	Pingelap*	Not seen
Mille	Mille*	Not seen

* Not visited by Field Trip ship, but reported by native informants.

Brown Rot of Breadfruit

The writer has observed this condition only on the variety "Bitaktak," although Johnny Silk, the school principal of Ebon Atoll, stated that he had seen it on "Bukaral". "Bitaktak" is the preferred variety of breadfruit, at least in the Southern Marshalls.

Symptoms are:

1. Lumpy or knobby appearance of the fruit, similar to that of the seeded variety "Mijwan." Normal "Bitaktak" is much more nearly a perfect ellipsoid.
2. Abnormally small size of the fruit.

3. Discoloration of the rind. Brown, roughly circular spots an inch or more in diameter appear on the surface of the fruit. This discoloration may extend to the core, but more commonly the portion of the fruit immediately beneath the brown rind is ripe, although the rest of the fruit remains unripe. That is, the flesh beneath the brown spot is yellow, soft, and has a fruity odor, instead of being white, firm, and nearly odorless (Bitaktak is normally picked green). In severe cases very small fruits may ripen and rot completely without falling from the tree.

Some informants stated that this condition was merely one of normal ripening, and that it occurred chiefly at the end of the bearing season, presumably on fruits which the owner had neglected to pick. Others said that they had noticed it only very recently. There was some disagreement as to the year in which the condition was first observed. The writer collected specimens of diseased fruits (pickled in 70 percent alcohol) and associated insects (copra bugs and fruit-fly larvae), and took color photographs of healthy and "diseased" fruits. Although the condition may not be abnormal or pathological in any sense, it merits further study by agriculturists of the Trust Territory. The distribution of brown rot of breadfruit in the southern Marshalls is:

<u>Atoll</u>	<u>First Observed</u>	<u>Remarks</u>
Arno	c. 1935; spread from Arno Island	Severe
Majuro	c. 1936	Not seen
Ebon	c. 1945	Severe
Namrik	Apparently not present	
Kili	Apparently not present	
Jaluit	c. 1949	Severe
Mille	"Always present"	Severe
Aur	Present; informant; Johnny Silk	

Caroline Islands

Moen (Truk)	Present; informant: Johnny Silk
Mortlok	" " " "
Losap	" " " "

The Phosphatic Rock at Ebon

Near the lagoon shore of Ebon Island four groups of piles of phosphatic limestone and soil were observed. Two groups of piles consist of chunks of phosphatic rock about 0.2 cubic feet in size. The piles are 125 to 150 feet long, 25 to 30 feet wide, and 3 to 5 feet high. Total volume of these piles is estimated at 64,000 cubic feet. Two other groups of piles consist of loose phosphatic sand and loam. The piles are roughly triangular in shape, and their total volume is about 25,000 cubic feet. The total volume of phosphatic rock and soil in the piles is thus approximately 89,000 cubic feet.

Assuming a density of about 1.7, the weight of the phosphatic rock and soil in the Ebon piles is about 5,000 tons.

According to local informants this phosphate was dug in the interior of Ebon Island by Ebon people under the direction of the Japanese and stored in specially constructed warehouses near the lagoon awaiting shipment. Several shiploads were sent to Japan, but American bombers prevented the loading of the remaining phosphate by destroying the warehouses and the miniature railway which facilitated loading. The phosphate workers were paid wages by the Japanese, but the owners of the land from which the rock was removed were not compensated, the phosphate being regarded by the Japanese as Ebon's contribution to the Imperial war effort.

The phosphate diggings in the interior of Ebon were visited. Although probably more than 50,000 tons of phosphatic rock and soil were removed, considerable amounts still remain -- perhaps 50 to 100 thousand tons.

Considerable deposits of phosphatic limestone were also observed at Takleb Island, on Arno Atoll. According to Felix, the magistrate of Arno, whose family holds land rights on Takleb, pineapples, tomatoes, bananas, and papayas formerly grew well there. Several members of the Trust Territory staff at Majuro have expressed desires to grow these plants. If phosphatic soil were transported from Ebon to Majuro, perhaps these and other desirable crops could be grown in places sufficiently protected from salt spray. A more significant use of the Ebon phosphate would be the possible alleviation of "laora" on several atolls of the southern Marshalls.

The Mille Mekinono

A "Mekinono" (a variety of breadfruit with deeply incised leaves) was observed at Mille, which, according to the local school teacher, bears the year around. Since all varieties of breadfruit in the Marshalls -- including Mekinono -- are usually strictly seasonal in their fruiting habits, this tree may prove to be extremely valuable. The variety is propagated vegetatively by root suckers, so that all its offspring should have identical fruiting characteristics. It is suggested that suckers be purchased from the owner and grown at Majuro. Grafts on small stocks of other varieties might be attempted. A special search should be made for non-seasonal varieties of breadfruit and pandanus and for plants of those or any other species the fruiting times of which do not coincide with the majority of varieties. These should be collected and studied in a central experimental garden. It is possible that eventually exchanges might be effected between the Marshalls and other Pacific Islands. The Marquesas, for example, are rich in cultivated varieties of breadfruit the fruiting seasons of which may possibly be different from those of the Marshallese varieties. Similarly, the Gilbert Islands possess many horticultural varieties of pandanus not found in the Marshalls.

The Mille Mekinono stands in front of the council house on Ngalu Island. It is said to belong to Laibon.

Notes on Insect Pests

A coconut tree infested with insects on Mille was pointed out to the writer. Larvae and adults of the insect were collected. ^{1/} The damage did not appear to be severe.

At Jaluit "white grubs" were reported on the leaves of the breadfruit.

The agricultural situation at Kili

The Bikini people now living at Kili Island have for at least the last two years relied heavily on imported foods. During the brief stop at Kili an attempt was made to assay the agricultural situation. The following food plants were observed:

1. Coconut. Although the growth and productivity of the trees appears excellent, copra production is not high (c. 60 tons/year). Most groves are very poorly maintained. Apparently little attempt has been made to cut back the brush, a common practice elsewhere in the southern Marshalls. In some places the undergrowth of "Arme" (Pipturus argenteus) and "Kangal" (Pisonia grandis) is so thick that collection of fallen coconuts must be nearly impossible.

Pandanus. The Bikini people relied heavily on Pandanus on their home atoll.. They have only 4 or 5 cultivated varieties at Kili, whereas at Bikini they probably had 20 or 30. The trees are by no means abundant at Kili, and there apparently is not enough of the thatching variety ("Benuk") to provide roofing material.

Yaraj (Micronesian taro -- Cyrtosperma chamissonis). In the interior of Kili Island stands a fresh-water swamp at least 20 acres in extent. This is eminently suitable for the cultivation of yaraj. Although a few yaraj patches were noted in the swamp, they appeared to be neglected, and over 95 percent of the swamp was overgrown with weeds, especially Jussiaea suffruticosa and Ipomoea tuba. Over 1000 pieces of yaraj were collected at Ebon and presented as a gift to the people of Kili.

Kutak (Hawaiian taro - Colocasia esculenta). A few neglected plants of two varieties were observed in the interior swamp. At the council meeting the people requested instruction in the cultivation of this important food plant.

Sweet Potato (Ipomoea batatas). Several patches were observed. The plants appeared healthy and well cared for. Instructions for cultivation were requested.

Breadfruit. Varieties Bitaktak and Bukaral present. There is ample potential breadfruit land. Some young trees have been set out, but many more could be planted.

1/ Brontispa chalybeipennis Zacher, according to Dr. J. L. Gressitt.
Distribution: Ponape, Kusaie, Marshalls.

Wet in Kabiling (Xanthosoma sp. or "yautia"). This is a taro-like plant cultivated in upland well-drained soils. Several patches were observed. The plants appeared to be well tended and are thriving.

Mokmok (Tacca leontopetaloides; "arrowroot"). Only one plant observed. This is an important food plant elsewhere in the Marshalls. It requires no care, and more should be introduced.

Bananas (Musa spp.). Bananas are planted in and around the village. A good deal of potentially valuable banana land is not being utilized.

Banke (Cucurbita pepo -- pumpkin). Several plants observed.

Kurak (Inocarpus fagiferus -- Tahitian chestnut). One mature tree.

Kotel (Terminalia catappa -- Indian almond). One immature tree.

At the council meeting a request for turkeys was made. Turkeys were formerly common in the northern Marshalls, but were confiscated by the Japanese during the war. Whether they would be successful in the wetter southern Marshalls is a matter of conjecture. Ducks and chickens are thriving at Kili; the former take full advantage of the central swamp. It is suggested that domestic geese be introduced to Kili instead of turkeys. Geese are large, hardy, fast-growing birds, and are able successfully to forage at large with virtually no supplementary feeding.

The general impression is inescapable that the resources of Kili are not being effectively utilized. The interior fresh-water swamp could easily produce yaraj sufficient to feed twice the present population. The coconut groves are sadly neglected. Banana production could be trebled in a few years with very little effort. It is my impression that the Kili people regard their present home as strictly a temporary one and are unwilling to invest labor on crops that they may never harvest. Indeed, the feeling may exist that if the resources of Kili were effectively utilized, the American authorities might decide that the situation was satisfactory. That is to say, by making a satisfactory adjustment to Kili the Bikini people might irrevocably prejudice their chances of returning to Bikini. Certainly the attitude that Kili is considered unsatisfactory was made very clear at the council meeting. The problems of Kili, however, are not basically agricultural.

Rats

On Jilang, Kejbwe, and Enidrik Islands of Arno Atoll rats damage a considerable proportion of the coconuts, by eating through the sides of the green nuts and extracting the milk and soft meat. These rats are said to be small and grey.

On the Possible Use of Dynamite

At Jaluit and Mille several small bomb craters were observed. In most cases the ground water was exposed in the pits. This suggested that taro pits might be conveniently excavated by the judicious use of small explosive charges. The method would be especially applicable on Mille Island, Mille Atoll, where the Japanese constructed their major airstrip in the southern Marshalls. It is impracticable for the Marshallese to attempt to dig taro pits through the cement runways of this strip, but the work could possibly be done cheaply and effectively with explosives, under the supervision of a competent civil engineer.

At Namrik and Kili copra loading operations are at best inefficient and at times actually dangerous. At Namrik copra is loaded from the shore into flat-bottomed boats, which are dragged across the ocean reef flat to a relatively high Lithothamnion ridge. The latter is exposed at low tide. At this point the heavy bags are transferred to Mokil boats, which are parked on the Lithothamnion ridge. The Mokil boats, are then towed or rowed to the field-trip ship. A channel blasted in the ocean reef flat from the Lithothamnion ridge to the shore would enable the Mokil boats to dock at the beach and be loaded directly.

General Remarks

At Council Meetings the Marshallese were especially eager to discuss agricultural problems. It is obvious that the Marshallese themselves have neither the training nor the economic means to investigate the causes and treatments of "laora", brown rot of breadfruit, and similar problems. Some technical assistance is necessary. Indeed, a program which had as its purpose the study of agricultural problems would seem to be one of the most concrete ways of "helping the Marshallese to help themselves." Such a program would involve at least the following provisions:

1. Periodic inspection and inquiry into local problems. This was attempted on the present field trip.
2. Detailed investigation of major problems. Field observations and analyses of soil suggest that phosphorus deficiency may be the cause of "laora," but experimentation in the field is necessary to test this hypothesis. Such experimentation could be conveniently accomplished on Arno Island, but it might require the continued presence of the investigator for several weeks. The Japanese agriculturists are said to have made long sojourns on several outlying atolls.
3. Collection and study of indigenous and introduced economic plants in a central experimental garden. This is essential to any long-term plan for the improvement of existing varieties and would form an important element in the training of the agriculturist himself. Few Americans have had first-hand experience or training in the cultivation of breadfruit or Micronesian taro, for example. Such a garden would serve also as a center for exchange of promising economic plants with other regions of the Pacific.

ATOLL RESEARCH BULLETIN

No. 56

Atolls visited during the first year of the
Pacific Islands Rat Ecology Project

by

J. T. Marshall, Jr.

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I. Acknowledgments

In connection with studies of rats on a typical Pacific high island, Ponape, comparative observations were made on outlying atolls. The Pacific Islands Rat Ecology project, supported by the National Science Foundation and the U. S. Public Health Service, is administered by the Pacific Science Board, with transportation provided by the Office of Naval Research and the U. S. Trust Territory of the Pacific Islands. These notes do not include definitive information on the rats, which will be treated in the official reports of the Pirate Project. Rather, they are intended to give a general impression of the little-known animal life of the atolls. I thank Mr. Del H. Nucker, High Commissioner of the Trust Territory, and his staff for innumerable courtesies and assistance which made this work possible and a pleasure; I thank also Mr. Henry Hedges, Ponape District Administrator, and his staff for facilities and for transportation. I am indebted to Oliver Nampei and C. E. Howell for hospitality and passage to and from Ant Atoll, and to Yeswo and Peter Marshall for assistance in the field work. I am grateful to the residents of the various islands for their hospitality.

II. General Remarks

In contrast with Arno Atoll in the Marshall Islands, the atolls of the Ponape District have a richer flora, providing a greater variety in the shapes and sizes of the plants. The vegetation is denser, the trees are taller, the undergrowth is luxuriant, and there are more epiphytes - all indicating a much more humid climate. There are more nesting sea birds. Because of their nearness to high islands such as Ponape, Kusaie, and Truk, there is a greater chance for the occurrence on them of land birds. The usual resident noddy terns (two species), black-naped tern, crested tern, and fairy tern were seen on high and low islands alike. Non-breeding shorebirds were generally distributed: Pluvialis dominica, Numenius tahitiensis (rare), Heteroscelus incanus, Arenaria interpres; on the other hand wintering Actitis hypoleucos and Calidris acuminata were seen only on Ponape. The toad Bufo marinus was found only on Guam, Ponape and Lele I., Kusaie. The land snail Achatina fulica was seen only at Ponape, Truk and Guam.

III. Descriptions of Certain Caroline Atolls

Mokil Atoll

I visited Kalap Island from 8 a. m. to 4 p. m. of November 29, 1955. Mokil Village is arresting in the beauty of its blue and white wooden houses on stilts, the orderliness of its coral pavements, the precise con-

struction of its stone landing piers and beautifully thatched boat houses and cooking houses (the same community organization and pride is reflected in the Mokil homesteading area at Ponape). For an atoll islet, Kalap is unusual in its great width, high elevations (hills of perhaps 25 feet), and enormous taro swamp, with the huge taros planted in rows.

In the tall forest, coconut husks, fronds and branches, though neatly piled at intervals, provided habitat for rats. One Rattus exulans was shot as it climbed a tree. About the town were domestic cats, pigs, ducks, and chickens. Reef herons (Demigretta sacra) are kept as pets, and are venerated (as the species name implies) as symbols or "ancestors" of certain families.

Carl Dannis, an educated Mokilese with extensive training as a sanitarian and as an assistant to the Rat Ecology project, stated that the Japanese used Manton Islet as a wharf and warehouse area, and that it was still over-run with large rats, presumably Rattus rattus; whereas he suspected that Kalap had possibly only R. exulans. He stated that the white-browed rail (Poliolimnas cinereus), which he well knew from live trapping at Ponape (specimens, not previously recorded from Ponape) occurred in the taro swamp. Although I saw none in the few minutes I looked there, I consider his report reliable.

Pingelap Atoll

Like Mokil, Pingelap has a tiny lagoon and broad land area for an atoll. There is a mangrove swamp in the lagoon. Huge pandanus trees lining the shore screen the village. During my visit from 1:30 to 5:00 p. m. on November 28, 1955, which was sunny and clear, there was a strong breeze. But the air was dead still in the tall jungle of huge coconut palms, breadfruits, pandanus and bananas of the interior. Ferns abounded both on the ground and up the trunks of the trees. There was much clearing of undergrowth, with the brush, logs, and husks piled in long rows. Again this neat arrangement offered better hiding-places for rats than if the material had been left scattered. A fairly large rat, possibly Rattus rattus, ran along such a wall of branches; and a young R. exulans was taken from a nest in a coconut stump. As at Mokil, huge skinks (Riopa albofasciolata) prowled among the pigs in their penned areas. A tame reef heron and a pet booby (Sula) were seen in the village. Anous tenuirostris and Gygis alba were nesting in the breadfruit trees at the outskirts of town.

"Atoll Strand" of Kusaie

Around the south and east border of Kusaie is a narrow coral strand with coconut palms, piles of coconut husks, Scaevola, tall pandanus, vines, and rank undergrowth. It is exactly like an atoll therefore, and I mention it here to show what land animals and birds can occur in a typical atoll environment which is very close to a source of colonists. My visit at this "coral strand" was only during November 25-26, 1955, and I cannot be certain that all the land birds live permanently there. All are species which made

long flights over the lagoon. Yeswo and I trapped and collected on a part of this strand connected to Lele Islet by a rock causeway. On the ocean side of the strand is a sand beach, then a lagoon, then an outer reef; on its inner border is mangrove swamp, then a rushing tidal river, then the steep forested mountains of Kusaie proper.

On Kusaie itself a richly tawny or reddish form of Rattus rattus occurs. But the Rattus rattus collected on the strand were predominately the black or plain brown varieties which prevail on Lele, the port; these were seen crossing the causeway in broad daylight. This means that the rat population of the strand is considerably isolated from that of the mainland.

Ant Atoll; Southern Portion

Peter Marshall and I stayed at Pohn Sanghi Village on the islet called Pukenng (Nikalap Aru I. on hydrographic chart) from December 9 to 12, 1955. We visited Imuntiatu Village and hiked to the western extremity of this islet, Panmuk. Coconut palms are throughout planted in rows with varying heights of undergrowth according to the time since trimming. At intervals along the shore, every 50 yards or so, are large native trees, in which most of the land birds were found. Breadfruits and tall symmetrical pandanus trees are present. The smallest islets, with beautiful sand beaches, have denser stands with more native trees such as Scaevola and Messerschmidia, and there are Pemphis and a few Sonneratia along the lagoon beach. At the broad west portion of Panmuk was a dense jungle, overgrown from former coconut plantings, with large remaining forest trees (with holes in which lorries were evidently nesting), a lush undergrowth including ferns and a taro swamp. There was much rain during our stay. Doubtless Ant gets much rain from the clouds which concentrate at windward Ponape.

Roof rats (R. rattus) raided copra drying sheds by day; these and R. exulans were trapped in abundance. None was seen in trees during night hunting. Domestic cats, dogs, pigs, and chickens occur. A school of porpoises played at the entrance to the lagoon; these animals performed double flips and double twists with ease in their jumps out of the water.

Ant Atoll, Alona (Wolauna) Islet

This remote islet at the northwest corner of the atoll was visited from May 14 to 16, 1956 by Peter Marshall, Yeswo and myself, in order to see what animals might occur in the untouched natural vegetation. All kinds of vascular plants that I could see were collected, and identified by F. R. Fosberg (I inadvertently missed Morinda, which was common, judging from fruit lying on the ground). The configuration of the vegetation may be judged from the following notes on the plant collections:

No. 153 Derris trifoliata Lour.

Small seedling growing in coral sand just within woodland edge at shore. No others seen.

- No. 154 Terminalia samoensis Rech.
Large tree, shiny leaves, trunk 2 feet in diameter. Abundant at periphery of islet, but back of Messerschmidia.
- 155 Polypodium scolopendria Burm. f.
Growing from rhizomes in patches in shade on coral ground. Also on large horizontal trunks of Messerschmidia. Common.
- 156 Cenchrus echinatus L.
Creeping and erect on coral ground at edge of woods just behind usual camp ground. Only the one patch, 10 feet across.
- 157 Pisonia grandis R. Br.
Smooth pale bark, roots sprawl over coral, many vertical shoots from big trunks. Abundant in interior.
- 158 Messerschmidia argentea (L.f.) Johnst.
Large tree in bloom, flowers white, and small green berries. Checkered dark bark. Abundant just along shore.
- 159 Pandanus tectorius Park.
Only one individual present. Few prop roots, just about 8 inches off the ground. Tree 12 feet tall, single trunk pale, bulges above ground. Leaf $6\frac{1}{2}$ feet long.
- 160 Asplenium nidus L.
Huge plant growing on coral ground in shade. Leaves $4\frac{1}{2}$ feet long. Only 2 others seen, both near this one; one of them was dwarfed and was growing out of a half coconut shell.
- 161 Cocos nucifera L.
Four or 5 old trees in center of islet, other seedlings planted and ringed with coral walls; other seedlings at far shore look as though the nuts have washed ashore and grown.

Note: No Scaevola sericea was seen on this islet.

The nearly elliptical islet is about 400 feet long. It is composed of jagged coral boulders built up to a peripheral rim with gravel and sand, but sunken and exposed in the interior sink. The shore is of coarse sand and gravel surrounded by a hard coral pavement covered at high tide and strewn with black coral boulders. A long white coarse sand spit extends southward about 200 yards. On it a large colony of Thalasseus bergii had abandoned their fresh eggs, which seemed to have been rolled by a high tide. The birds protested our presence and dived at us but never returned to their eggs.

Gygis alba and Anous tenuirostris nested in the trees; many of the latter's dense population were dead and dying. Droppings were profuse but I saw no actual deposits of guano; the material seems to drain out from the coral interior, though it must contribute to the raised dark sandy border. The

dominant vegetation is the dense closed canopy of Terminalia, Pisonia, and Messerschmidia about 30 feet high. All other plants seem to be accidental or local. Part of the raised loamy border is clear and park-like beneath the canopy; either bare or with "lawns" of Polypodium.

In late afternoon hundreds of frigate birds (Fregata minor) and boobies (specimen sent to USNM) gathered, circling overhead, and after dark they began to land in the trees, all coming in from the same direction.

Five or six reed warblers (Acrocephalus luscinia), a large population for so small an islet, sang constantly in the trees. Only a couple of house flies were noted despite the numerous dead noddies. We were bitten by long-legged delicate flies a little smaller than the house fly. Cockroaches and ants (including a biting kind) swarmed over the whole islet. One earthworm was seen. Small crabs set off most of the rat traps and tiny hermit crabs abounded. No herons, rats, bats, toads or snails were found.

Oroluk Atoll

Yeswo and I visited Oroluk on June 5-6, 1956. This huge atoll is mostly an elliptical reef, with only a small islet at one end. This has a natural forest with Pandanus understory at the west end, open plantings of coconut palms in the central part, and a large papaya garden with taros and dense weeds. At the edge of the beach is Messerschmidia and some dense grass. Pisonia grandis, Morinda, Calophyllum and Asplenium nidus were seen. The ground is of white sand at the beach, followed inland by larger coral fragments, and the interior has stinking black mud from bird droppings. Three men from Kapingamarangi were staying at the island; they had captured 27 adult female green tortoises, which were taken back to Ponape. These had been laying eggs in the beach sand. Others were seen in pairs in the lagoon. Domestic pigs and chickens were present. Eleven roof rats (R. rattus) were trapped, mostly in the thatched buildings. These were all remarkably alike in color even to a white spot on the chest. This gives the impression of inbreeding within the progeny of perhaps a single recently-introduced pregnant female -- in marked contrast to the heterogeneity typical of all other rat populations I have trapped in Micronesia.

Invertebrates noted were small day-biting mosquitoes, large coconut crabs (which carried off the rat traps), purple square land crabs, ghost crabs on the sand, hermit crabs, katydids. There was a large nesting colony of Fregata minor and boobies (Sula -- apparently both S. sula and S. leucogaster) in the native trees to the north.

I estimated the dense population of starlings (Aplonis opacus) at about 400, 95% adults. They differed visibly in size and color, suggesting a mixed stock. Families of juveniles begging food from their parents were dusky ventrally with indistinct streaking. But I saw at least one grown bird whose ventral color was white with clear black streaks. Some of the calls of these starlings differed from those on Ponape. They were shabby as if heavily parasitized (as were my specimens with mites).

These tame birds entered the houses. They spent much of their time in the very large papaya gardens and left none of the fruit for human consumption. The Kapingamarangi people used a slingshot against the birds, with which I collected two. Both had mended serious bone fractures yet were of normal behavior. This starling also occurs on Kapingamarangi Atoll, reported by Niering in Atoll Res. Bull. No. 49.

Conclusions on nesting and roosting oceanic birds. ---

Unlike the small noddy terns and fairy terns (which roost and nest successfully on inhabited atoll islets) the large boobies, frigates, and terns are limited to seldom visited islets such as Alona and Oroluk. Native policies of preserving nesting sanctuaries for turtles and large oceanic birds should be encouraged.

IV. Distribution of Resident Land Vertebrates on Caroline Atolls, 1955-56.

On the accompanying table the fauna of the high islands, presumably the source of some of the animals of atolls, is entered for comparison as is that of Arno Atoll, Marshall Islands. Kusaie was visited November 23-27, 1955, Ponape from August 1955 to July 1956; Moen I., Truk from June 20 to 28, 1956. All the following were observed in numbers and are presumed to be permanently established and able to carry out their entire life cycle on the island indicated. The Ponape mountain starling is still established over a large area of forest, but is very rare.

Table 1.
Distribution of resident land vertebrates.

(Islands are arranged from west to east, distances apart in miles entered between their names).

Animals	Islands	Distances in miles, approx.												
			Truk	235	Oroluk	185	Ant, Wolauna I.	Ant, Pukerange I.	10	Ponape	100	Mokil	65	Pingelap
													165	Kusaie (coral strand)
														Kusaie
													600	Arno
<i>Rattus rattus</i>			*	*	*	*	*	*	*	*	*	*	*	*
<i>Rattus exulans</i>			*	*	*	*	*	*	*	*	*	*	*	*
<i>Rattus norvegicus</i>			*	*	*	*	*	*	*	*	*	*	*	*
<i>Mus musculus</i>			*	*	*	*	*	*	*	*	*	*	*	*
<i>Pteropus</i> (large, not molossinus)			0	*	*	*	*	*	*	*	*	*	*	*
<i>Emballonura</i>			*	*	*	*	*	*	*	*	*	*	*	*
Deer (2 species)			*	*	*	*	*	*	*	*	*	*	*	*
Cat, feral			*	*	*	*	*	*	*	*	*	*	*	*
Pig, feral			*	*	*	*	*	*	*	*	*	*	*	*
<i>Dasia smaragdina</i>			0	*	*	*	*	*	*	*	*	*	*	*
<i>Emoia</i> of Truk			*	*	*	*	*	*	*	*	*	*	*	*
<i>Emoia boettgeri</i>			*	*	*	*	*	*	*	*	*	*	*	*
<i>Emoia arnoensis</i>			*	*	*	*	*	*	*	*	*	*	*	*
<i>Emoia cyanura</i>			0	*	*	*	*	*	*	*	*	*	*	*
Striped bronze <i>Emoia</i>			0	*	*	*	*	*	*	*	*	*	*	*
<i>Leiopisma noctua</i> ?			0	*	*	*	*	*	*	*	*	*	*	*

* Specimens collected and deposited in U. S. National Museum, some duplicate bird skins are in the collection of the Southwestern Foundation of Vertebrate Zoology, Los Angeles.

0 Observed but not collected

Table 1. (cont'd)

Animals	Islands											
	Distances in miles, approx.	Truk 235	Oroluk 185	Ant, Wolauna I. 10	Ant, Pukerange I. 100	Ponape 100	Mokil 65	Pingelap 165	Kusaie (coral strand) 600	Kusaie 600	Arno	
Riopa albofasciata		: 0 :	: 0 :	:	: * :	: * :	: 0 :	: * :	:	:	: * :	
Gehyra oceanica		: 0 :	:	:	: * :	: * :	: * :	: * :	:	: 0 :	: * :	
Perochirus articulatus		:	:	:	: * :	: * :	:	:	:	:	: * :	
Lepidodactylus lugubris		: 0 :	: * :	: 0 :	: * :	: * :	: 0 :	:	: 0 :	:	: * :	
Gymnodactylus pelagicus		:	:	:	: * :	:	:	:	:	:	: * :	
Demigretta sacra		: 0 :	:	: 0 :	: 0 :	:	:	: 0 :	: 0 :	:	: * :	
Nycticorax caledonicus		: 0 :	:	:	:	:	:	:	:	:	:	
Ixobrychus sinensis		: 0 :	:	:	:	:	:	:	:	:	:	
Anas superciliosa		: 0 :	:	:	:	:	:	:	:	:	:	
Gallus gallus, feral in jungle		: 0 :	:	:	: * :	:	:	:	: 0 :	:	:	
Poliolimnas cinereus		:	:	:	: * :	: ? :	:	:	:	:	:	
Ptilinopus porphyraceus		: 0 :	:	:	: * :	:	:	:	: 0 :	:	:	
Ducula oceanica		:	:	: 0 :	: * :	:	:	:	: 0 :	:	: * :	
Gallicolomba xanthonura		: 0 :	:	:	: * :	:	:	:	:	:	:	
Trichoglossus rubiginosus		:	:	: 0 :	: * :	:	:	:	:	:	:	
Asio flammeus		:	:	:	: * :	:	:	:	:	:	:	
Collocalia inquieta		: 0 :	:	:	: * :	:	:	: * :	: * :	:	:	

Table 1. (cont'd)

Animals	Islands	Distances in miles, approx.	Truk 235	Oroluk 185	Ant, Wolauna I. 10	Ant, Pugenng I. 100	Ponape 100	Mokil 65	Pingelap 165	Kusaie (coral strand) 600	Kusaie 600	Arno
<i>Halcyon cinnamomina</i>		:	:	:	:	0	:	*	:	:	:	:
<i>Edolisoma tenuirostre</i>		:	:	:	:	:	*	:	:	:	:	:
<i>Acrocephalus luscini</i>		:	0	:	:	0	:	*	:	*	:	:
<i>Rhipidura rufifrons</i>		:	:	:	:	:	*	:	:	:	:	:
<i>Myiagra oceanica</i>		:	0	:	:	:	*	:	:	:	:	:
<i>Metabolus rugensis</i>		:	0	:	:	:	:	:	:	:	:	:
<i>Aplonis opacus</i>		:	0	:	*	:	*	:	*	:	*	:
<i>Aplonis pelzelni</i>		:	:	:	:	:	*	:	:	:	:	:
<i>Myzomela cardinalis</i>		:	0	:	:	*	:	*	:	*	:	:
<i>Zosterops conspicillata</i>		:	0	:	:	:	*	:	:	:	:	:
<i>Zosterops cinerea</i>		:	:	:	:	:	*	:	:	*	0	:
<i>Rukia sanfordi</i>		:	:	:	:	:	*	:	:	:	:	:
<i>Erythrura trichroa</i>		:	0	:	:	:	*	:	:	:	:	:
<i>Lonchura nigerrima</i>		:	:	:	:	:	*	:	:	:	:	:

* Specimens collected and deposited in U. S. National Museum, some duplicatesbird skins are in the collection of the Southwestern Foundation of Vertebrate Zoology, Los Angeles.

0 Observed but not collected.

Conclusions on reptiles. — There is no impoverishment of the lizard fauna on sizeable atolls remote from the high islands; for instance, the faunas of Ponape and Arno (Atoll Res. Bull. #3) are practically identical, and have the same number of species, though each has one species not found on the other. Therefore the lizard faunas of atolls are independent of proximity to high islands.

Inasmuch as the 1955-56 lizard collections have not yet been identified by experts, I merely assume, through familiarity in the field, their identity with species on Arno. In case my suppositions are wrong, the following descriptions are offered for provisional identification:

Diurnal Skinks

Dasia smaragdina large, green (with color polymorphism: olive, brown, black); trees.

Truk Emoia medium-small, brown above, light gray beneath; ground and vines.

Emoia boettgeri medium, brown above, yellow below; ground.

Emoia arnoensis medium, black; ground.

Emoia cyanura small, dorsally striped, bluish tail.

Striped Emoia small, bronze back, striped sides, pale venter; ground.

Leiolopisma noctua? small, bronze back, blackish sides, pink beneath; under leaf litter.

Riopa albofasciolata very large, dusky above, pink beneath, black hash-marks along lower jaw distinguish even the juveniles; ground.

Nocturnal Geckos

Gehyra oceanica large, tail narrow; arboreal.

Perochirus articulatus medium, tail like arrow-head; houses.

Lepidodactylus lugubris small, tail like arrow-head; houses, trees.

Gymnodactylus pelagicus medium, no frills on toes; ground.

Tentative conclusion on birds.--- Several kinds of land birds can occupy the atoll environment where a high island is a nearby source of replenishment (within sight, as at Ant).

V. Non-native birds on atolls

Kwajalein I., Kwajalein Atoll, Marshall Islands.--- On June 11, 1950 I saw a mynah (Acridotheres tristis) perched on the main airport building. During several days' stay in July 1956, I noted at least a half-dozen at the gardens around this same building, now used as a nursery. They were eating papayas.

Wake Island.--- During a sojourn on July 19-21, 1955 I saw a male English sparrow, Passer domesticus, alight on the quonset at the west end of the Transocean Airlines BOQ area on July 20th.

The ease with which non-native animals are now being transported is illustrated at Guam, where the following were unheard-of in 1945. I saw at the U. S. Naval Hospital (June 28-July 15, 1956) several pairs of tree sparrows, Passer montanus, and a small flock of rice birds, Munia oryzivora. In addition the musk shrew, Suncus murinus, is now common, and there are reliable reports from sanitation officials of a large green snake and an anopheline mosquito.

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Preliminary report on the flora of Onotoa Atoll, Gilbert Islands

by

Edwin T. Moul

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PRELIMINARY REPORT ON THE FLORA OF ONOTOA ATOLL, GILBERT ISLANDS

by

Edwin T. Moul

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This report represents the second part of the preliminary report on the work of the General Naturalist, from June 15th to August 30th, on the Pacific Science Board's 1951 Expedition to Onotoa in the Gilbert Islands. The project was supported by funds granted to the National Academy of Sciences by Contract N7onr-291 (04), NR 388-001 with the Office of Naval Research. The generous cooperation of the U. S. Navy Department, the U. S. Coast Guard, and the Military Air Transport Service is acknowledged.

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INTRODUCTION

The report on the animals of the atoll has been published in the Atoll Research Bulletin #28, May 31, 1954. A preliminary report on the Geology of the atoll by Dr. Preston E. Cloud, Jr. can be found in the same publication #12, December 15, 1952.

The atoll of Onotoa (see map), totalling 5.2 square miles of land, is divided into 3 large inhabited islands designated as North Island, South Island and Tabuarorae and four quite small uninhabited islands known as Aonteuma, Abanekeneke, Nanntabuariki and Abeinringan. A population of approximately 1800 people live in this small area, hence all land that is at all useful has been planted in coconut groves. The smaller islands are primarily of coral gravel soils and supported a few coconut trees, with the exception of Nanntabuariki which had only scattered shrub growth. Sixty species of flowering plants have been identified. About 15 of these which are cultivated were confined to the village areas. A few species were represented by only one or two plants on the whole atoll.

VEGETATION

Coconut groves

Most of the land on the larger islands was covered with coconut trees. Small groves were also present on two of the smaller islands. The groves were generally made up of randomly scattered trees of varying heights and ages; a

few recently planted ones (on formerly inhabited sites) were in regular rows and of uniform size and age.

The aspect of the coconut plantations varied with their location on the atoll, with the substratum and ground water conditions. Dense stands of coconut palms forming a continuous canopy, grew on the limesand soils (Cloud loc. cit., pp. 22, 58). Such vigorous groves were typical of the lagoon side of the islands, along the village road. They formed dense shade and had few understory plants. Young coconuts and Pandanus were usually present. Near the villages a few Ficus trees were found in these groves and appeared to have been planted. In the more or less well tended dense plantations, the soil surface was usually bare, except for a few grasses and herbs, Lepturus, Stenotaphrum, Euphorbia, Sida and Fimbristylis all growing widely scattered. In many areas an accumulation of fallen leaves and husks littered the soil and may have contributed to the sparseness of ground cover vegetation. The densest stand of Stenotaphrum observed on the atoll formed a complete ground cover in a grove on the North Island, where the soil surface had been cleared of all litter. Adjoining our camp site also on the North Island was a stand of coconut trees reported to be 15 years of age. These trees were planted in regular rows and were of uniform height. The owner had kept the soil clear of litter and in the dense shade the herbaceous vegetation grew widely scattered.

In contrast to these heavy groves, were the thin, irregular stands, usually located down the center of the large islands and on the seaward side, but generally on lime sand soil. Since the canopy was quite open, the understory here was well developed and showed an increased number of species. Messerschmidia, Guettarda, Pandanus, Scaevola and young coconuts formed the understory and, in some cases, very dense thickets. The ground cover here was also more extensive and consisted of mixed or pure stands of Sida, Lepturus, Fimbristylis, Triumfetta and Euphorbia. Blue-green algae and mosses covered the soil in many places between the clumps of herbs.

A few very poor groves occurred on the three larger islands on lime sand soil, but were more common at the exposed extremities of these islands on fine coral gravel soil and on the small islands of Aonteuma and Abanekeneke where the soil was also coral gravel. These stands consisted of a few widely scattered trees, usually old and sometimes infected with bracket fungus. The understory where developed was a dense thicket of Scaevola and Guettarda. The ground cover consisted of the same herbs listed above.

The effect of the recent year and a half of drought (1949-50) could be seen near the south end of South Island. The width of the island at this point is only about 50 feet from lagoon beach to seaward ramparts. The fresh water lens must have completely disappeared or become so shrunken that salt water penetrated into the soil, for nearly all the coconut palms were dead in this area. Scaevola, Pandanus and Guettarda did not show any serious effects.



ONOTOA, GILBERT IS

-  Turtle grass
-  Mangrove
-  1 Fathom line
-  10 Fathom line

2 MILES.

Adapted from map by P. E. Cloud.

Clearings

At intervals along the length of North Island occurred irregular clearings. There were no indications as to their origin. Lack of plantings and/or carelessness on the part of the owners may have been the reason for their existence. The soil appeared to be the same as in the best coconut groves.

In these clearings were found scattered thickets of Scaevola and Guettarda with some Pandanus and an occasional tree or clump of Messerschmidia. Many babai pits (taro) had been dug throughout this area. Generally one or two Messerschmidia trees were found growing at the edge on the mounds of earth. The dead leaves of this tree were gathered, piled up and later used as mulch around the Cyrtosperma (babai) plants in the pits.

The ground cover consisted of large irregular clumps of Sida fallax, Lepturus, Portulaca and Euphorbia chamissonis. In many cases these patches were of one species only. The bare areas of white sand between them had a broken crust of blue-green algae (Scytonema spp.) with mosses growing on it.

Area of Brackish Pools

East of the village of Buariki on North Island and at the northern end of South Island were two areas of brackish pools. The soil was a silty lime type termed "caliche" by Cloud (loc. cit.). Widely scattered coconut trees were growing there. They were dwarfed and did not seem to bear a heavy crop of coconuts. Pemphis grew around the edges of the pools and in small thickets. Young coconut trees occurred in the understory, even in great abundance, on South Island. On North Island only scattered culms of Fimbristylis were present with crusts of blue-green algae covering much of the bare sand between them. On South Island the ground cover in this area was more lush and included Lepturus and Portulaca.

Vegetation of the Seaward Ramparts

Thickets of Scaevola grew on top of the ramparts and showed signs of damage by salt spray on the seaward sides. Pandanus also grew sparsely along the top of the ramparts or back of the Scaevola either singly or in groups, and also showed signs of damage by salt spray. However some of these plants were able to produce large fruits in this situation. Messerschmidia was less common on the ramparts than Pandanus, occurring now and then on the crest. Cassytha was rare here, but occasionally grew on Scaevola.

On the inner slope of the ramparts, the vegetation was sparse and scattered, with areas of white sand between. Few coconuts grew on the slope, but the groves started at their base. Scaevola bushes grew on the slopes and down into the groves. Pandanus, Messerschmidia and Guettarda were more common on this slope than on the ramparts. Cassytha was rare here, but did parasitize Scaevola. Culms of Fimbristylis, alone or with Lepturus, were spotted here and there. Sida fallax and two species of Portulaca were also part of this community.

At the north end of North Island the rampart vegetation consisted of a pure stand of Pemphis. These shrubs attained a height varying from 10 to 15 feet and formed almost solid hedge-like thickets, broken by the paths made by the natives going through to the seaward reef.

Vegetation on Gravel Soil

At some places on the seaward side of the islands, on the northern point of North Island and on Aonteuma, Abanekeneke and Nanntabuariki the soil consisted of coarse and fine gravels. These were areas reached by waves and probably flooded during periods of storms. A few isolated Scaevola and Guettarda bushes were conspicuous against the bareness of the area. Some small Pisonia trees were found here, their leaves badly damaged by leaf cutting bees. Pandanus and Morinda citrifolia were represented by occasional dwarfed specimens. Lichens were collected on the bark of Guettarda growing in this habitat on Aonteuma.

The chief herbs on these areas were both species of Boerhavia, Sida fallax and the two species of Portulaca. The Boerhavia plants were large and the total spread of single plants reached as much as 8 feet. These were distributed widely, some growing in the shade of the Guettarda or Scaevola shrubs, while others were in the open. The few Sida plants were large and shrubby, but showed yellowing of the foliage. The Portulaca plants were in isolated clumps or as scattered individuals. Cassytha was common on the Guettarda and Scaevola bushes.

Further back from the shore line coarse coral fragments graded into finer fragments. The vegetation remained primarily the same, with the addition of a few isolated coconut palms. Premna was common on Aonteuma island on this fine gravel. Lepturus and Phyllanthus were additional ground cover plants, but only the latter really common.

Pisonia Groves

Some scattered Pisonia trees were located on the coral gravel areas on Aonteuma Island and on the north end of North Island, but on Tabuarorae there were two distinct narrow groves of large trees over 40 feet in height. These groves were on a ridge of indurated phosphatized limesand soil and the odor and droppings under these large trees indicated a big bird population. The nests of the smaller noddy tern were occupied at the time of our visit on July 25th. The soil was bare directly under the trees except for dead branches and fragments of logs, all soft and spongy. However, on both sides of the groves the vegetation was the most luxuriant seen on the atoll. The greatest number of species were also noted here. The predominant understory plant was Ficus, but young breadfruits, papayas, both flowering and bearing fruit, Guettarda, Pandanus and young coconuts were also present. A wide variety of herbaceous plants covered the ground under this shrub understory.

Vegetation around Fish Ponds & Sand Flats

At the north end of North Island was a large fish pond which ended in extensive sand flats, partially flooded at high tide. The greatest concentration of mangrove, Rhizophora mucronata, bordered the fish ponds and grew on the part of the sand flats flooded by the tides. The only other mangroves observed were 2 trees and many small seedlings growing in the shallow calcareous sand of the embayment between Aonteuma and North Island.

The wetter sand flats, flooded at very high tide, had a heavy stand of mangrove that extended almost completely across. The fish pond was almost completely encircled by mangrove thickets growing in the shallow water. Back of the mangroves on higher ground was a zone of Pemphis, and coconut palms beyond the Pemphis.

The bottom of the fish pond was covered almost completely with turtle grass, Thalassia hemprichii. Green algae, mostly a species of Microdictyon, grew as epiphytes on the turtle grass.

The highest sand flats appeared to be dry most of the time and were flooded at only extreme high tides. The central part of these flats was bare white sand riddled with burrows of fiddler crabs. Pemphis formed a shrub border, but all of the shrubs that had grown far out on the flats were dead, only those along the edge were still living. Groves of coconut palms grew down to the edge of the flats.

Babai pits (Taro pits)

The cultivation of Cyrtosperma for food was quite extensive on the atoll. Pits had been dug to a depth of 15 feet in the limesand soils in the center of the three large islands. Many of these were in the areas described above as clearings. On Tabuarorae there were many abandoned pits.

Since these pits were generally moist or flooded shallowly with water from the fresh water lens, algae samples were taken in many of them. Blue-green algae, Phacus and Rhizoclonium were common. Complete identification of the fresh water algae from these pits is being made.

A variety of flowering plants grew in these pits. Eleocharis geniculata and Cyperus laevigatus were common, the latter was quite abundant in several abandoned pits on Tabuarorae. The only banana plants seen on the atoll grew in one of the babai pits. Several large shrubs of Jussiaea suffruticosa were found growing in a pit east of the village of Aiaki.

The pits varied in size, but usually were between 25 and 30 feet long, with a width of 10 to 20 feet. Mr. Richard Turpin, the British Land Commissioner, told me that in some cases as many as 10 individuals owned little plots in a single pit. In many pits the natives had built up the humus around the largest plants by using mats of coconut leaves to form a circular wall and then had filled this with the leaves of Messerschmidia and

Guettarda along with the blackish sand found under old trees of these species. Some of the larger babai plants were flowering. Only in a few cases were the plants in a single pit of the same size.

Vegetation of sand dunes

On the southern tip of North Island, the southern tip of South Island and the northern tip of Tabuarorae are a series of low sand dunes. These areas are hot during the middle of the day because of their exposure to the sun. The white sand between the scattered shrubs causes an extreme glare.

The principal shrubs were Scaevola, Guettarda and Pemphis. These were the only shrubs present in this community on North Island, but on South Island and Tabuarorae Suriana, Sophora and Terminalia were also growing. Suriana, however, was common only on Tabuarorae. Cassytha had parasitized a number of these shrubs. Grasses and herbs were rare and since the sands were apparently shifting from time to time, no moss nor algae were present.

SPERMATOPHYTA

Sixty species of vascular plants were collected or observed by the author on Onotoa between June 24th and August 30th, 1951. In the following species list is included a short account of the occurrence and abundance of the plants. Native use is included whenever observed or learned. The author's collection number follows the name of the island on which collections were made. Native names obtained are included only if supplied by more than one authority. The first and second set of plants are deposited in the U. S. National Herbarium and the Herbarium of the Bernice P. Bishop Museum at Honolulu. The other duplicates are in the Chrysler Herbarium at Rutgers University, New York Botanical Garden, Gray Herbarium at Harvard, University of California Herbarium at Berkeley and the private herbarium of Dr. F. R. Fosberg.

Angiospermae: Monocotyledonae

PANDANACEAE

Pandanus tectorius Sol.

North Island 8364, 8412.

A list of native names supplied by our cook, Baru is given below. He also supplied information on the use made of some of these varieties by the natives.

te aramaru)
te aramarieba)
te bakororso
te ulonau
te aramoroia

both with small phalanges, leaves
used for mat weaving.

te iribaikawa
 te tina
 te iritawatawa - tall straight trunk, used for supports in house building.
 te aranteba
 te annabai
 te irikiri
 te iriauriaria - large fruited variety, blackish cast on leaves

This is one of the three important plants in the native economy. It grows on limesand soils under the coconuts and on the fine gravels. Salt damaged specimens grew on the ramparts and a few stunted ones on the coarse gravels.

At one spot on North Island, new plantings had been made by taking a crown from a branch, tying the leaves together and planting these cuttings rather deep into the soil. These new plantings were in irregular rows in the shade of coconut trees.

The ripe fruit is known as "te tou". The fruit is taken apart and cooked, then the pulp is pressed from the base of the phalanges and spread on Guettarda leaves to dry in the sun. During the drying process the mass or pudding is usually covered with flies. It is called "te tuae". If this pudding is mixed with water, as a soup, it is then called "te kabubu".

HYDROCHARITACEAE

Thalassia hemprichii (Ehrenb.) Ascherson

Lagoon 8188.

Large beds of this aquatic plant were found in the north end of the central lagoon along the shore of North Island at the village of Taneang. The plants were deeply rooted in the limesand bottom and the leaves were only about 6 inches long. These beds were covered at low tide. The plants grew so densely that they caused the deposition of sand and fine silt. The green alga, Microdictyon, and a small gelatinous red alga were very abundant, both attached and floating among these weeds. Halimeda stuposa also grew in these areas. The bottom of the fish pond at the northern end of North Island was almost completely covered with Thalassia and many fish and invertebrates were present in the weed patches and on the individual plants.

GRAMINEAE

Cenchrus echinatus L.

"te anti".

North Island 8386; South Island 8206.

Found in just two sites on the atoll: thick solid stands are common along the road north of the village of Aiaki, and several single plants were growing along the road on North Island at our supply dump, south of the Government area. It seems certain this is a recent introduction and will probably spread undisputed over the atoll before long. The native

name given is the one used in the northern atoll of Makin and was supplied by Jim Redfern, our interpreter from Makin.

Lepturus repens (Forst.) R. Br.

North Island 8019, 8454; South Island 8212.

The commonest grass on the atoll, found on all the islands, the largest stands on the limesand soil, but rarely forming a turf. On the poorer soils, only widely scattered culms were present and usually in association with Fimbristylis cymosa. Scattered clumps grew on the seaward beach ramparts. The most vigorous plants were found along the lagoon roads.

Stenotaphrum micranthum (Desr.) Hubb.

North Island 8055, 8155.

The second most important grass on the atoll, restricted to the three large islands. It was found growing on limesand soil in the dense shade of coconut groves. It was also rather common around the edges of the babai pits in full sun. Many of the stands of this grass were dense and continuous in contrast to those of Lepturus. In the grove north of the Protestant Church, in the village area of Buariki on North Island was found the heaviest and largest stand anywhere on the atoll, covering almost completely a 5-acre tract.

Eragrostis amabilis (L.) W. & A.

"te uteute ni mwaane".

North Island 8130, 8339; South Island 8207.

Found as a turf at various places along the village road on both North and South Islands. Also common along paths in the center and north end of North Island. On Tabuarorae it grew on a narrow piece of high ground between the lagoon and the shrubby growth on the sand flats. Growing mixed with Cenchrus on South Island.

Wherever this grass was seen the soil seemed to be wet and dark in color with a great amount of humus. It was usually found only on the finer soils in which there were few or no gravel particles.

Eragrostis whitneyi Fosb.

"te uteute ni mwaane".

North Island 8090, 8316.

Confined to North Island. Growing on limesand soils along the lagoon road and along a path in a sunny area in the center of North Island. Common where it was found.

CYPERACEAE

Cyperus laevigatus L.

Tabuarorae 8224.

Collected only on this island in an abandoned babai pit. The bottom of the pit had a very shallow layer of water and the soil was held firmly by the roots and rhizomes of the plants. Formerly it was used for weaving.

Eleocharis geniculata (L.) R. & S.

North Island 8158, 8337; South Island 8210.

Growing in some of the babai pits on North and South Islands. Not abundant in any of the pits.

Fimbristylis cymosa R. Brown

"te uteute ni aine".

North Island 8021, 8129, 8281; South Island 8208.

A very common sedge on all the islands of the atoll, growing as scattered plants, never as a turf. Many of the culms on the beach ramparts and inner slope of the ramparts were dried up and apparently dead. Pure stands were frequently seen in the coconut groves along the lagoon road, at other places Fimbristylis was growing mixed with Lepturus. Around the brackish pools in the area of "caliche" soil on North Island this was the only vascular plant forming ground cover.

PALMACEAE

Cocos nucifera L.

"te ni".

North Island 8373; 8411.

Distribution of coconut palms on the atoll has been discussed in describing vegetation and need not be repeated here. The coconut is certainly the staff of life of the Onotoan. It supplies him with food, toddy, shelter, rope, matting, flooring, oil and medicine. The dried product of the nut is sold to the local cooperative trading company where commodities from the outside world can be purchased.

The gathering of the "toddy" was one of the most fascinating aspects of the coconut culture. Why certain trees were selected and others disregarded for toddy collecting I never did learn. However, it was said that some trees produced more than others. Toddy trees could be spotted, since notches were cut on the lower part of the trunk. The flower buds of these trees were tied shut to keep them from opening, then the tips were cut off. The dripping sap from these cut tips was drained into a bottle or empty coconut shell by using a leaflet of coconut as a gutter. Each morning and evening the young men or boys climbed the toddy trees and replaced the

filled containers with empty ones, making a fresh cut on the bud each time. The gatherer sat on the petiole of one of the large leaves and accompanied his labor with singing. To gather toddy and not sing would cause it to spoil. It was unearthly, but beautiful to hear these voices from the tree tops at dawn and dusk. All the singers had fine voices. Usually the songs were unfamiliar, but "From the Halls of Montezuma", "Silent Night, Holy Night", "You are My Sunshine", and some other familiar tunes with Gilbertese words were also heard at these times.

The toddy is used fresh, mixed with water and is then called "karawe". If the toddy is boiled to keep it from fermenting it becomes a brown syrup and then mixed with water as a refreshing drink it is called "kamaimai". It has the flavor of coca cola that has become somewhat flat from standing. If the toddy is allowed to ferment, which requires special permission, it becomes highly intoxicating. We saw its effect upon a young man who passed out while dancing at one of the feasts. A beetle of genus Sessinia gets into the toddy and if not noticed and removed causes a painful inflammation of the urinary tract.

Other native names associated with the coconut are as follows:

te ben --- a ripe coconut
te riki -- a germinating coconut
te mormoto - a drinking coconut

Pritchardia sp. ?

A single plant of a fan-palm growing in front of the Government House on North Island.

ARACEAE

Cyrtosperma chamissonis (Schott.) Merr. "te babai"

North Island 8132, 8157, 8159; South Island 8211.

Extensively cultivated in pits dug in the limesand soil to a depth of 10 to 15 feet. This was the only species found in cultivation for the starch stored in the roots. Plants of all sizes, some in bloom, were found in the pits. The natives build a circular wall of coconut matting around individual plants and build up a compost, using the leaves of Messerschmidia and Guettarda mixed with darkened limesand soil from under the older trees of these species.

The land tenure of these pits was rather interesting. The families using the pits usually did not own the land in which they were dug, but permission had been granted to their ancestors several generations before. Frequently, as many as 10 different families had plantings in one pit, none of which was larger than 20x50 feet; most were smaller. The only abandoned pits seen were on the eastern side of Tabuarorae.

Since the pits were dug to a depth that would intersect the water table, algae, principally blue-greens and Rhizoclonium, covered the wet soil or grew in the shallow water. One pit had a bloom of Phacus pleuronectes in it. Mosquitoes and dragon flies bred in these pits, as indicated in the report on the animals (Moul, 1954).

AMARYLLIDACEAE

Crinum asiaticum L.

"te kiepu".

North Island 8304.

Planted as an ornamental around the village houses, but not common. Also found planted in one of the cemeteries. Very few specimens were flowering during our stay on the atoll.

MUSACEAE

Musa sp.

Observed only once on the atoll: There were three trees in one of the babai pits on North Island. The plants were small and yellow green in color. In contrast, banana was common in the villages on Makin Atoll in the Northern Gilberts.

Dicotyledonae

MORACEAE

Artocarpus altilis (Park.) Fosb.

"te mai".

North Island 8299.

Breadfruit trees were planted on each side of the village streets along the lagoon shore. Many of the trees were small. Young trees were planted in a circular well lined with reef rock and the roots covered with humus and dead leaves. Coconut matting was used to cover the soil, allowing the young trees to grow between the mats. Many of the trees in Aiaki village were small and poor and some of them were dead. The largest trees were in the village of Tekawa, which is located on the widest part of North Island. All the trees along the street in the village of Tabuarorae were dead. The natives reported this to be the result of the 1949-1950 drought. The fruits seen were small, wrinkled and contained large seeds.

On the island of Tabuarorae, breadfruit trees of several sizes were seen in the luxuriant vegetation along the edges of the Pisonia grove. This area was underlain with phosphate deposits, attributed to the birds nesting in the Pisonia trees. These groves were formerly more extensive and covered the area where the breadfruits were now growing.

Ficus tinctoria Forst.

"te bero".

North Island 8057, 8128; Tabuarorae 8232.

Small trees were found growing on the three large islands. From their distribution it seemed apparent that most of them had been planted. These trees were growing around the edges of many of the babai pits and, in one case, in an abandoned pit. Others were planted around the houses in the villages. On North Island a row had been planted at regular intervals along a path through the coconut grove. On Tabuarorae they formed small thickets around the Pisonia grove. The fruits were small and used as food.

URTICACEAE

Fleurya ruderalis (Forst.) Gaud. ex Wedd.

"te nekeneke".

North Island 8147, 8336; Tabuarorae 8228.

Common only at one spot on North Island, around a copra hut. Very common in many stands under the Pisonia trees on Tabuarorae. A native girl brought specimen 8336 to camp to trade for cigarettes. I presume these plants came from North Island.

NYCTAGINACEAE

Boerhavia diffusa L.

"te wao".

North Island 8037, 8039, 8085, 8106, 8134, 8340; South Island 8198; Abanekeneke 8141.

A common plant of the seaward side of the islands, growing on both the fine and coarse coral gravel soils. Frequently found on the beach ramparts, sometimes under dead or living Scaevola shrubs. It was very common all over the coral gravel of the old village site on Abanekeneke. In some cases the sprawling plants spread a distance of 4 feet in all directions from the root. Both flowers and fruit were present on most plants. The flowers were pink in most cases, but a few of the plants assigned to this species had white flowers. These plants showed some intermediate characters between this and B. tetrandra and may be hybrids. (8141, 8198).

This and B. tetrandra are used as food for hogs.

B. tetrandra Forster

"te waonnansi".

North Island 8084, 8151; South Island 8202; Tabuarorae 8223.

The rarer of the two species found on the atoll. Growing on coral gravels and boulder ridges of the seaward side of North and South Islands. On Tabuarorae, however, it was very common on the limesand soils in the thin coconut groves. Flowers and fruit were present on most plants. The flowers were white in this species.

Pisonia grandis R. Brown

"te buka".

Aonteuma 8082; North Island 8152; Tabuarorae 8229.

Two long narrow groves of these trees about 40 feet tall were found on a ridge of indurated phosphatized limesand soil (Cloud 1952) on Tabuarorae. The only other specimens seen were a few trees on the north end of Aonteuma on coral gravel and two small groups of trees on North Island. One of these groups on the north tip of the Island grew on coral gravel and the other group was near the brackish pools on the seaward side of the island. The trees on Aonteuma and North Island had leaves badly damaged by leaf-cutting bees.

The large trees on Tabuarorae had large buttressed trunks; many would have required at least three men with arms extended to completely encircle them. The wood was very soft. The odor of ammonia was strong under these trees, due to the excrement from the large colony of nesting terns. The most luxuriant vegetation on any of the islands was on either side of these groves and consisted of Ficus, papaya, Morinda citrifolia, breadfruit saplings, with a heavy ground cover of Fleurya and grasses.

Bougainvillea spectabilis Willd.

The record for this plant is based on the appearance of the flowers in a "lei" worn by one of the girls on August 16th. On questioning her, it was learned that the plant grew in the yard of the house assigned to the native preacher of the village of Buariki.

Mirabilis jalapa L.

A cultivated ornamental planted around some of the houses in the village of Aiaki on South Island.

PORTULACACEAE

Portulaca lutea Solander

"te mtea".

North Island 8022, 8073, 8089, 8341, 8451.

The larger leaved of the two species growing on the atoll. Great variation was noticed in the coloring of the stems of these plants, some were red.

Growing on limesand and coral gravel soils and in the groves, clearings, and on beach ramparts and their inner slope. Observed on all the islands of the atoll. In places on coral gravels it formed thick stands. The natives reported that it was used as pig food and as human food in times of famine.

Portulaca samoensis V. Poelln.

"te mtea".

North Island 8023, 8072, 8107, 8284, 8395; South Island 8199.

Distribution much the same as the other species and used by the native population for the same purpose. Apparently no distinction is made by them between the species.

LAURACEAE

Cassytha filiformis L.

"te ntanini".

North Island 8056, 8058, 8431.

A parasitic member of the family having a superficial resemblance to dodder (Cuscuta). It was found growing principally on Scaevola sericea and Guetarda speciosa, occasionally attached to Euphorbia chamissonis and Pemphis. One plant was found growing on Suriana maritima, on the island of Tabuarorae. Common along the beach rampart, rarer on the inner slope, but frequent in the sunny open areas in the center of the large islands. Widespread in the atoll wherever the host plants grew. Flowers and fruit were present during the expedition's stay on the atoll.

HERNANDIACEAE

Hernandia sonora L.

"te nimaa repwurepwa".

South Island 8195.

One small tree, possibly the only one on the atoll, found along the lagoon road south of the village of Aiaki on South Island. The wood was formerly used for outriggers.

LEGUMINOSAE

Delonix regia (Boj.) Raf.

"te tau".

North Island 8296.

One small tree, 6 feet tall, growing beside a house in the village of Buariki, North Island. Flowers and fruit were not present. This was the only specimen seen on the atoll.

Sophora tomentosa L.

"te nikamaatuutuu".

South Island 8192; Tabuarorae 8154.

A common shrub on the narrow southern tip of South Island where the coconut trees had been killed by the drought. Growing on dune sands. The only other occurrence was on Tabuarorae as a member of the shrub community on the sand flats and bordering the inlets at the northeast end of the

island. Flowers and fruit were present on most of the shrubs.

SURIANACEAE (often included in the SIMARUBACEAE)

Suriana maritima L.

Tabuarorae 8226, 8308.

This shrub was common only on Tabuarorae. It grew on dune sand on the shore of the lagoon and as a member of the shrubby thicket on the flats at the northeast corner of the island. Fairly common as a member of the understory of the coconut groves on this part of the island. Young seedlings were present. The only other specimens seen were on the lagoon shore in the village of Buariki on North Island.

EUPHORBIACEAE

Euphorbia chamissonis Boiss.

"te tarai".

North Island 8059, 8365.

This plant, with Sida fallax, formed low shrubby thickets in the center of the large islands and in many clearings in the coconut plantations. In the shade of the groves on the fine limesand soil, scattered plants of this species were frequently the only ground cover. In other groves it grew with Lepturus and Sida to form the ground cover. It was second in importance to Sida. The natives made no use of this plant.

Euphorbia prostrata Ait.

North Island 8092, 8146.

Not a common plant, but abundant where it grew. It was the dominant ground cover in the deep shade of a coconut grove at the north end of North Island. The coral gravel spread around the village houses was usually kept clear of vegetation, but in the village of Aiaki on South Island this plant was abundant in a number of these gravel yards.

Phyllanthus niruri L.

North Island 8087, 8148; Tabuarorae 8231.

Growing in the coconut groves on the three large islands, but not a common member of the ground cover. Found on lime soils and fine coral gravels. Restricted to the village areas along the lagoon. At the extreme northern end of North Island it was confined to an area of scattered copra huts. One of the common herbs found in the Pisonia groves.

SAPINDACEAE

Dodonaea viscosa (L.) Jacq.

"te kaipora".

Aonteuma 8083; North Island 8303.

Found growing as a low shrub in the thin coconut grove on Aonteuma. Later, several plants were observed in the village of Buariki. Used in scenting the oil for the hair.

TILIACEAE

Triumfetta procumbens Forster

"te kiaou".

North Island 8040, 8094, 8105, 8131; Tabuarorae 8234.

Fairly common on the larger islands. It was found growing on the ramparts on dune sand and was also rather common on sandy soil in the central portion of the islands. In coconut groves it frequently grew up between and over the litter scattered on the ground; some of the runners were as long as four feet. It was in flower and fruit during the period of our stay on the island.

Used medicinally by the natives for poultices and drunk as tea during child birth. Also reported used as soap.

MALVACEAE

Hibiscus rosa-sinensis L.

These plants were reported as growing in the compound of one of the native preachers, but were not located. On August 13th one of the native girls was observed with these flowers in her hair.

Hibiscus tiliaceus L.

"te kiaiai".

North Island 8300, 8306, 8449.

Only two groups of these trees were found on the atoll and both were on North Island. The trees growing along the lagoon shore in the village of Buariki were the largest and were in full bloom during our visit. The other group of trees were at the south end along the road in the village of Temao. Here there was one old tree surrounded by many small ones.

The flowers, yellow with red centers, were used as ornaments in the hair of the villagers.

Sida fallax Walp.

"te kaiao" and "te kaura".

North Island 8020, 8088, 8282.

One of the most widely distributed ground cover plants on the atoll,

growing at some places to a height of 2 feet. It was found on all types of soil, but was most abundant on the limesand soils under the coconut trees. Plants growing on the coral gravels were usually chlorotic. Flowers and fruit were present during the whole period of our stay on the islands. The larvae of the common butterfly, (Hypolimnas bolina), were abundant on the foliage.

The flowers were the favorite for making the head "leis" that everyone wore. Children following along with the collector made "leis" as they went, and the author rarely came back from an expedition without wearing one contributed by them. Sometimes the plants are used as part of the compost for the babai pits.

GUTTIFERAE

Calophyllum inophyllum L.

"te itai".

North Island 8127; South Island 8203.

This tree was rare on the atoll. There were two large trees in a coconut grove on North Island. Another single tree about 25 feet tall was located east of the lagoon road at the south end of South Island. Flowers and fruit were lacking. The trees were observed in bloom on the Atoll of Majuro in the Marshall Islands on the trip to Onotoa. The lumber was formerly used in canoe building. Because of the present scarcity, it was now being used only for canoe paddles. A brown skipper butterfly was caught on the leaves of this tree and another observed flying about. These insects were observed nowhere else on the atoll and were probably specific to this plant.

CARICACEAE

Carica papaya L.

North Island 8150, 8153; Tabuarorae 8230.

Planted around a few of the houses in the villages; but not a common cultivated plant. Many small plants were found around an isolated copra hut at the north end of North Island. The largest number were growing in and around the Pisonia groves on Tabuarorae. The plants were in flower and fruit during our stay on the island. The natives sold us the fruit which we ate for breakfast. They were of good quality and quite good flavor.

LYTHRACEAE

Pemphis acidula Forst.

"te ngea".

North Island 8036, 8050, 8086, 8315.

One of the common shrubs of the atoll, growing on sand dunes at the ends of the larger islands and on the gravel soils of the smaller ones.

In some places it formed thickets on top of the seaward ramparts. It was common also along the lagoon shore away from the villages. On North Island it formed a complete zone between the Rhizophora and the coconut palms at the margin of the fish ponds and also grew on the tidal flats at the upper end of the ponds. Shrubs that had grown far out on these tidal flats were now dead, probably from the higher salinity resulting from the drought of the last year and a half.

In two areas of brackish ponds, one on North Island and one on South Island, Pemphis formed the dominant shrub of the understory.

Flowers and fruit were present during our stay on the island. A Catocala-like moth (Achaea janata) was very abundant on foliage. Cassytha filiformis grew on Pemphis occasionally.

Jussiaea suffruticosa L.

South Island 8209.

Several large shrubs grew in a wet babai pit east of the village of Aiaki. These were the only specimens seen. The flowers were yellow and were present on the same shrubs with ripe seed pods.

BARRINGTONIACEAE

Barringtonia asiatica (L.) Kurz

"te usi".

South Island 8205.

One small immature tree in a shallow pit on South Island, south of the village of Aiaki. The leaves were large, dark green and glossy with short red petioles. No fruit nor blossoms were observed on Onotoa. Ripe fruit were seen on Makin, Gilbert Islands, on the trip to Onotoa.

One afternoon in the Maneaba (Community house) at Aiaki, as I was passing around plant specimens in order to secure the native names, one of the group of natives told the interpreter that this tree was the only one on the atoll and was on his land. He added that the young fruit was used to poison fish and, in the old days, to poison people.

RHIZOPHORACEAE

Rhizophora mucronata Lam.

North Island 8051, 8098; Aonteuma 8077.

Confined to the north end of North Island and an embayment between it and Aonteuma. The largest stand surrounded the fish ponds and the tidal flats at the upper end of the ponds. Only two small mature trees were growing in the Aonteuma embayment, but there were many small seedlings all along the lagoon shore. The trees were in bloom and also had fruit with pendent radicles.

COMBRETACEAE

Terminalia samoensis Rech.

"te ukina".

Aonteuma 8081; South Island 8191; Tabuarorae 8225.

A few widely scattered specimens of shrub size found only on the three islands listed above. They were growing on dune sand or coral gravel soils. The fruit on the Aonteuma specimens were green on July 9th. The fruit collected on South Island on July 23rd, and Tabuarorae on July 26th were scarlet. One large tree grew on the seaward rampart on South Island. The fruits were used as decorations and in making "leis". Apparently they were not eaten.

ARALIACEAE

Polyscias guilfoylei (Cogn. & March.) Bailey

"te butatora".

North Island 8305.

Planted in hedges. Observed in the villages of Buariki, Taneang-Tekawa and Aiaki. The leaves were green and white and the dried plants were very fragrant.

APOCYNACEAE

Catharanthus roseus (L.) G. Don.

"te buraroti".

North Island 8279.

One of the common ornamentals planted around the village houses. The white and purple flowered varieties were observed.

Nerium oleander L.

"te orion".

North Island 8302.

One small shrub at a village house in Buariki. The natives knew it contained a poisonous substance.

CONVOLVULACEAE

Ipomoea tuba (Schlecht) G. Don

"te ruku".

North Island 8338; South Island 8197.

This plant was found only at the two sites represented by the collections. It was most abundant on South Island near the seaward side, where it was very common and formed a dense tangle on trees, shrubs and ground. On North Island it was growing on the coral gravel soil of the rampart and was not abundant. Neither fruit nor flowers were observed.

Reportedly used as medicine to attract the girls. The common Ipomoea pes-caprae, so abundant on the island of Betio at Tarawa Atoll and on other islands visited, was missing here.

BORAGINACEAE

Messerschmidia argentea (L.f.) I. M. Johnston "te ren".

Aonteuma 8076; North Island 8156, 8279.

A common tree of the atoll, growing on all the islands except the very small ones. Frequently found in the coconut groves and a common member of the understory on Tabuarorae. It was more abundant along the seaward rampart and along the edges of the clearings. One to several of these trees always grew on the edges of the babai pits. The leaves were collected and used for compost around the babai plants. It grew on sand and gravel soils. It was in flower and fruit during our stay.

Messerschmidia was commonly infested with a caterpillar, probably the larval stage of a small Nymphalid butterfly, and also the colorful moth Utetheisa. The moth was usually at rest on the underside of the leaves.

VERBENACEAE

Lantana camara L.

This plant was not collected. It was growing around one or two village houses. It was used by the girls as hair decoration.

Clerodendrum inerme (L.) Gaertn. "te inato".

Aonteuma 8080; North Island 8298.

Small shrubs which tended to be vine-like, were growing on Aonteuma. They were in thickets of Guettarda and Scaevola and under the coconuts. The soil here was coral gravel. Neither flowers nor fruit were present.

They were also found around some of the houses in the village of Buariki. The flowers were used in making "leis".

Premna obtusifolia R. Br. "te aango".

Aonteuma 8078; South Island 8194, 8196.

A common shrub of the south end of Aonteuma, growing on coral gravel soil. The only other occurrence was on the lagoon shore of South Island, south of the village of Aiaki. Here some of the shrubs grew to a height of fifteen feet. Flowers and fruit were present during our stay on the atoll. Premna was reported to be used as a medicine. Some of the leaves showed damage by leaf-cutting bees.

SOLANACEAE

Physalis lanceifolia Nees

North Island 8093, 8149.

A few plants growing beside a copra shack at the northern end of North Island. No other specimens seen, both collections being made at the same site. Flowers and fruit were present.

SCROPHULARIACEAE

Russelia equisetiformis Schlecht & Cham.

"te kaibaun".

North Island 8167, 8307, 8387.

A common plant around the Residency and the village homes.

Collections were made only on North Island, but the plant was present on South Island and Tabuarorae. The scarlet flowers were highly prized for "leis".

ACANTHACEAE

Pseuderanthemum carruthersii Seem.

"te roti".

North Island 8038, 8301.

Commonly cultivated and growing around the houses in all the villages. In the cemeteries at the northern and southern tips of North Island, a number of graves had these shrubs growing at one end. Two varieties were observed. One variety had purplish-green leaves, dark twigs and magenta flowers. The other variety had green leaves and light colored twigs. No flowers were observed on the latter.

RUBIACEAE

Guettarda speciosa L.

"te uri".

North Island 8041, 8280, 8333; Aonteuma 8079.

Second in importance to Scaevola as an understory tree and thicket former. It was found on all types of soils on all the islands, including the very small coral gravel islands between North and South Islands. Flowers and fruit were present during the time we were on the atoll. It was frequently parasitized by Cassytha filiformis.

The fragrant flowers were used by the natives for "leis". The women spread a dozen or so leaves on the ground on which to dry the pandanus pulp. The skin from the fruit of this plant, with a part of the root of Scaevola, were said to be used to cure venereal disease. These were crushed

together, the juice put into a drinking coconut and this mixture drunk by the patient. One treatment is said to be effective.

Morinda citrifolia L.

"te non".

Abanekeneke 8104, 8140; Tabuarorae 8227.

This plant was found growing principally below the ramparts on the seaward side of the islands. Also a member of the Pisonia grove community. It most frequently grew on coral gravel soils. Signs of damage by salt spray were evident on the small island of Nanntabuariki. The trees on North Island had been attacked by the leaf-cutting bees. A large Sphingid caterpillar, larva of the day-flying hawk moth, was found on the foliage of the trees in the cemetery on North Island. The tree was also planted around the houses in the villages. Both flowers and fruit were present during our stay on the island. The fruit is used as food in times of famine, but apparently not highly regarded or used at other times.

GOODENIACEAE

Scaevola sericea Jahl

"te mao".

North Island 8024, 8283, 8396.

The commonest understory and thicket former on the atoll. It was present on all the islands and grew on all types of soil. It formed dense thickets in the neglected coconut groves. On the seaward ramparts it formed solid thickets at many places and these plants showed a considerable amount of killing by salt spray. New shoots, however, arise directly from the root stock. It was in flower and fruit during the time we were on the atoll and was frequently parasitized by Cassytha filiformis.

COMPOSITAE

Vernonia cinerea (L.) Less.

"te waonnansi"

South Island 8193.

This small composite was found growing along the lagoon road both north and south of the village of Aiaki, South Island. It was fairly common in this area, but not found at any other location on the atoll. The flowers were light purple.

PTERIDOPHYTA

No members of this group of plants grew on Onotoa.

Polypodium scolopendria was common on Majuro Atoll, Marshall Islands. IX/5/51.

BRYOPHYTA

The mosses and liverworts collected on the expedition to Onotoa were determined by Dr. H. A. Miller and samples retained in his collection. Duplicate specimens were distributed to the Herbaria indicated above.

Because of the irregular amount of rainfall on Onotoa, with long periods of drought, Bryophytes were not common on the atoll. Mosses grew on the lime-sand soil along roads and paths and on soil bare of vascular plants. The heaviest growth was in the shade of trees. Most of the moss patches were surrounded by a thick growth of terrestrial blue-green algae. Black tufts of Scytonema ocellatum frequently were mixed with the moss plants and suggested the presence of another species. Only one species of moss was found and no liverworts were collected on Onotoa. Dixon (1927: Jour. Bot. 65:254.) has previously recorded Brachymerium indicum (Doz. & Mott.) Bry. Jav. as occurring on Onotoa, but this species did not show up in the collections. Miller indicates the one species found to be Brachymerium melanothecium (C. Müll.) Jaeg. and states that it is widespread in Oceania. The following collections were made:

North Island 8060, 8061, 8095, 8176.

South Island 8213.

Tabuarorae 8241.

On the trip out to Onotoa from Kwajalein Atoll, there were opportunities to collect on the various atolls visited. These collections are included below.

MUSCI

Calymperes tenerum C. Müll.

Majuro Atoll, Marshall Islands.

8002. Growing on the trunk of a palm tree in a shaded area,
Rogeron Island, VI/18/51.

8621. Growing on a breadfruit tree, Rogeron Island. VI/18/51.

Kwajalein Atoll, Marshall Islands.

8001. Base of palm tree. Kwadak Island. Species widespread in Oceania. (Miller, 1953, p. 5).

Calymperes thyridioides Broth.

Majuro Atoll, Marshall Islands.

8005. On rotten wood in a Scaevola thickets. Uligak Island.
VI/19/51.

Previously reported from Arno Atoll and other places in the Marshalls as C. moluccense by Miller, 1953, p. 4. (Miller personal correspondence).

HEPATICAE

Archilejeunea mariana (Gott.) St.

Kwajalein Atoll, Marshall Islands.

8000. On the bark of Pisonia trees. Fairly common on the horizontal branches. Wooded center of Kwadak Island. VI/17/51.

According to Miller (Correspondence) this is a rather depauperate specimen but falls within the range of the species. Widespread in Oceania.

Hygrolejeunea vesicata (Mitt.) Stephani

Majuro Atoll, Marshall Islands.

8003. On the trunk of a palm tree. Rogeron Island. VI/18/51. Miller states (Correspondence) that he believes this species belongs in Cheilolejeunea. The material from the Marshalls is slightly smaller than the type.

LICHENES

The few lichens found have been turned over to Dr. George A. Llano, Maxwell Field, Alabama, for determination. These collections were made in dense thickets on the bark of Guettarda, Morinda, Pandanus and coconut trees.

FUNGI

The fungus collections made on Onotoa have been turned over to Dr. Donald P. Rogers at the New York Botanical Garden and determinations have not been made at this date.

A number of species of bracket fungi were collected on rotting logs. The commonest was a red polypore. A reticulate orange slime mold was found on decaying pandanus leaves. A white gilled fungus was collected several times from the base of living coconut palms. Fungus beetles were present in some of the specimens collected.

Soil Flora

Samples of soil were collected on the atoll and brought back to the Department of Microbiology at Rutgers University. The analysis of the flora of these soils was made through the kindness of Dr. R. L. Starkey and Dr. Hubert A. Lechevalier. I quote from Dr. Starkey's report:

"These represent determinations for numbers of bacteria and actinomycetes determined by the customary agar plate procedures.

Sample No.	pH	Numbers of microorganisms, per gram of soil		
		Bacteria	Actinomycetes	%Actinomycetes
8335	8.0	328,000	4,957,000	94
8243	8.4	200,000	3,982,000	95
8332	8.0	971,000	2,100,000	68
8120	8.0	1,705,000	6,140,000	82

It is to be noted that the reaction of all soils was distinctly alkaline. Of particular interest is the fact that the numbers of bacteria were in all cases lower than those of actinomycetes and that with 3 of the 4 soils more than 80 per cent of the colonies that developed on the agar plates were those of actinomycetes. A similar observation was made with soil obtained some years ago from Bikini. This is contrary to what one expects to find in soils of temperate regions particularly those of humid climates. These soils are generally acid (pH 6.0 or less) and the percentage of the total colonies that are produced by actinomycetes generally vary between 5 and 40 per cent.

The predominance of actinomycetes is interesting in view of the fact that many of these organisms produce antibiotics. It is possible, therefore, that the actinomycetes affect the transformations of material in the soils by their antagonistic effects. It is also possible that some actinomycetes may be obtained from these soils that will serve some useful purpose as producers of new chemotherapeutic substances."

Sources of the Soils

- 8120. Lime sand soil from the center of North Island.
- 8243. Lime sand soil from Tabuarorae under vegetation.
- 8332. Soil from babai pit. North Island.
- 8335. Soil from under Guettarda tree, south end of North Island.

ALCAE

Taxonomy and Distribution of Algae

The algae from Onotoa include both fresh-water and marine forms. The fresh-water habitats include the soil surface, the babai pits and the brackish pools. The marine habitats include the beach rock, lagoon and the seaward (windward) reef. Many of the lagoon collections were made by Dr. Preston E. Cloud, Jr., Dr. Donald W. Strasburg and Dr. A. H. Banner while carrying out their own explorations. The identification of the algae is still in preliminary stages and much material remains to be determined. The identification of the Myxophyta to species has been done by Dr. Francis Drouet at the Chicago Museum of Natural History and specimens are deposited there. As identification proceeds complete sets of all algae are being deposited in the U. S. National Herbarium, Bernice P. Bishop Museum, and the Chrysler Herbarium at Rutgers University. Duplicates have been distributed to the New York Botanical Garden, University of California Herbarium at Berkeley, University of Michigan Herbarium, Farlow Herbarium at Harvard and the Herbarium of the University of Sao Paulo, Brazil.

The following report includes a limited and preliminary discussion of the ecology of the algae on the atoll, followed by a species list of the algae identified to date. It is the hope of the author to publish a detailed final report on the algae at a future date. A paper on the Halimeda and Caulerpa of the atoll is already in manuscript form and will be submitted for publication shortly.

Algae of the soil surface.

The surface of the road that parallels the lagoon from North Island to Tabuarorae was covered by a "skin" of blue-green algae. This was also true of the well-worn paths and the soil where it was bare of vascular plants and remained undisturbed. Two species of Schizothrix and Scytonema hofmannii were very common and formed the bulk of this association. Other blue-greens occurred with these principal species. Some black moss-like tufts growing around areas occupied by mosses proved to be Scytonema ocellatum. The dune sands of the seaward rampart and the lagoon shore had Microcoleus chthonoplastes and Scytonema hofmannii as the dominant algae. It is interesting to note that this species of Microcoleus is the dominant alga covering the peat surface on the salt marshes of New Jersey. These terrestrial blue-greens were present as a soil covering on the bare areas all over the atoll, both in sun and shade.

It has been established that many of the blue-greens, especially those belonging to the Nostocales, can fix nitrogen. The presence on the soil of vast sheets comprising many species suspected of having this ability may be very significant in the productivity of the soil. This is probably an important method by which this element is made available to higher plants (Newhouse, 1954, p. 53). The holding of soil against wind erosion is another important contribution of this group of plants.

Algae of the babai pits.

The native taro, called babai (Cyrtosperma chamissonis), is grown in pits dug to the water table. The amount of water present in the pits varied from 6 inches of standing water to just enough to dampen the soil. In all the pits thick mats or scums were present. Collections of these scums were made in many of the pits, and the algal flora showed considerable variation. In some, Rhizoclonium hieroglyphicum was dominant. In others, members of the blue-green algae, such as Anacystis dimidiata, Plectonema nostocorum and Coccochloris stagnina, were dominant. One pit sampled had as the dominant form Phacus pleuronectes; associated with it were members of the genus Euglena.

Here again members of the Myxophyta were probably contributing available nitrogen compounds to the soil and thus to the growing babai plants. The algae here were the primary producers in the food chain that supported the protozoa, rotifers, nematodes, ostracods, and eventually the dipterous larvae and dragonfly nymphs present in these pits.

One of the fresh-water wells used by the natives in the Government Area on North Island was found to have a mat of Rhizoclonium hieroglyphicum floating on the water surface. The water level in the well was approximately 8 feet below the surface of the soil. The opening of the well was between 3 and 4 feet in diameter which admitted sufficient light for growth.

Algae of the brackish pools.

In the area of caliche soil on the Pemphis flats at the north end of North Island there were a number of brackish pools (Cloud: 1952. Atoll Res. Bull. 12:60). These pools were covered by a floating, orange-colored gelatinous mat. The shaded portions and the under surface of the mat were olive-green in color. Two species of Anacystis were the dominant algae, with Coccochloris stagnina and three species of Lyngbya also present. The bottoms of these pools were lined with a more granular and warty mat. The same species were present, but the Lyngbya species were more abundant. A similar association for brackish pools has been reported by Newhouse (1954, p. 42). The same association of living organisms described above for the babai pits was present in these pools.

MARINE HABITATS

The distribution of the marine algae is best discussed under the two major marine habitats, the lagoon and the seaward (windward) reef. There are beach rock associations in both areas that have somewhat different associations of algae present.

A complete description of the geology and topography of the lagoon has been published by Cloud (1952, p. 18). Algal growth in the lagoon as a whole was relatively sparse. The areas of the lagoon are described below with an account of the principal algal species present.

Beach rock of the lagoon.

At a number of places along the shore of North Island there were outcroppings of beach rock. Near the village of Taneang a long ridge extended out from the beach at an angle of 45°. Collections of algae made from the surface of these rocks showed two species of Entophysalis as dominant, with Calothrix pilosa and Nostoc muscorum also present. These species proved to be present on beach rock at other places on the lagoon shore. Newhouse (1954, p. 45) reports this association as the most ubiquitous on Raroia, from high tide line to below low tide on the lagoon shore. He also reports the dark coloration on the surface of the rocks due to discoloration of sheath material of Entophysalis by exposure to sunlight. This dark discoloration was also evident on Onotoa.

Shoreward from the ridge and sheltered by it, the lime-sand bottom had become hardened to the consistency of hard putty and had the same blue-green algae on the surface as listed above; however, at about one fourth inch depth was a second layer of blue-greens which consisted of Oscillatoria nigro-viridis, Lyngbya confervoides and Phormidium valderianum. It is proposed by Cloud (1954) and others that these blue-greens are binding the lime silt into beach rock. This same type of double-layered association was present at other places along the lagoon shore.

Frequently the beach rock had been eroded and shallow oval tide pools formed at different levels. These solution pools have been studied by Cloud (1954). They were filled with water by the high tide and the shallow bottoms were covered with algal growth. A solid mat of an alga tentatively identified as Enteromorpha compressa grew in these pools. Other collections from the pools are awaiting determinations.

Lime-sand shoals.

The central lagoon along the shore of North Island had a fine lime sand bottom, populated by great numbers of sea cucumbers. Microdictyon and Bryopsis pennata were collected in the wash along the beach. Because of the shoal condition it is possible to wade and swim out into the lagoon about a 1000 feet. The algae were sparse on this shallow flat. Patches of a filamentous, gray colored species have been determined as Lyngbya confervoides. It grew on the sandy bottom, and as it proliferated it tended to accumulate mounds of the fine silt with only the ends of the filaments protruding. Farther out were small patches of Turbinaria ornata with Microdictyon growing with it. Caulerpa uvilliana was collected on rock fragments beyond the end of the jetty. The pebbles in this area were covered with pink coralline growth.

Thalassia beds

North of the jetty on these sand flats there were large patches of Thalassia hemprichii that formed an almost solid stand. Attached to these plants and floating free among them was a species of Microdictyon.

Hydrocoleum floccosum was common along the shoreward edge of these beds. Caulerpa serrulata and Halimeda stuposa were present in the sandy areas between the Thalassia plants.

Northern lagoon.

Between the Thalassia beds and Aonteuma Island was a gravelly flat on which grew some living coral. At low tide these flats were covered by only about a foot of water, so the coral masses in many cases were truncated. The algae here were growing in sand pockets scattered between the masses of dead and living coral. Halimeda stuposa was the common alga here. Many of the specimens had developed thick heavy stipes that penetrated deeply into the sandy substrate. Lyngbya confervoides formed mounds of silt as described above. Dictyosphaeria intermedia, Boodleia van bossae and Caulerpa urvilliana were other common algae present. Laurencia grew on some of the coral knobs.

These same species were present on the shallow reef flat northeast of Aonteuma, but there was an increase in the number of Halimeda plants, including another species, Halimeda taenicola. Turbinaria ornata and Dictyurus purpurascens were also found here. Laurencia grew in the tide pools. A crustose coralline alga covered the surface of this reef in many places.

Western lagoon and reef.

The greatest concentration of algae species in the lagoon was on the western (leeward) reef and the coral knolls in the western part of the lagoon. Most of the Halimeda species found on the atoll were collected either on the reef or on the coral knolls. Many of these knolls were surrounded at their bases with a circle of Halimeda, but these did not form extensive meadows over the bottom as one sees in Florida. Caulerpa elongata, C. urvilliana, Dictyosphaeria cavernosa and Valonia aegagrophila were common in this area. Polysiphonia and Dasya were epiphytic on other algae. Coralline algae (Porolithon) formed huge spherical masses on the coral knolls, and crustose forms were covering the dead coral.

The deepest part of the lagoon was west of the village of Aiaki, South Island. Here on a bottom of dead and living coral at 48 feet grew Halimeda bikinensis and H. tridens forma tripartita.

Passage and Central lagoon reef.

Between North Island and Abenekenek Island was a passage covered with flowing water even at low tide. Most of the bottom was fine sand, but on the occasional dead and living coral grew Caulerpa urvilliana, Laurencia and many fine red algae. Frequently the rhizoidal process of the Caulerpa would grow off the coral and trail across the sandy bottom.

A shallow reef flat adjacent to the passage and extending into the lagoon at the southern tip of North Island was dry at low tide, except for the tide pools. Cladophoropsis, Dictyosphaeria, Valonia, Caulerpa urvilliana and Enteromorpha were growing on this reef. In the tide pools, Lyngbya confervoides grew and accumulated mounds of silt as observed before. Laurencia and Goniolithon also grew in the tide pools. The algal cover on this reef was sparse.

The seaward reef.

The seaward (windward) reef flat was covered by a fine algal turf. The distribution of the algae on this reef was studied by observations and collections made from time to time during July and August. After Dr. A. H. Banner had established a transect (A) to study the invertebrate fauna, one square foot of algal turf was scraped from the reef along this transect and preserved. These collections were made at 50 foot intervals, except where the flora showed no perceptible change. The accompanying table (1) shows the distribution of the principal species as determined at this time.

This reef can be divided roughly into five areas. Starting at the vegetation line on the beach rampart there is a sloping sandy beach or an outcropping of beach rock. On the sand at the high tide line there was usually a drift deposited after each high tide which included shells, seeds, plant fragments and algae of the reef.

The beach rock here had the same dark gray color on the surface as that present in the lagoon, the color being due to the presence of species of Entophysalis. The upper tide pools were 5 to 6 feet above the reef flat and were filled with water only from the splash of waves at high tide. They had a slimy black coating on the bottom formed by a species of Lyngbya. The slime coating was thin in these top pools and it was necessary to scrape vigorously to collect it. The middle pools were $3\frac{1}{2}$ to 2 feet lower and contained a mat of twisted yellowish or brownish filaments. Entophysalis conferta, Lyngbya confervoides, L. semiplena (8064, 8067) and Enteromorpha (8066) were the principal species in these pools. Naviculoid diatoms were also present. Water entered these pools from the waves at high tide. Lyngbya meneghiniana (8350) was the alga of the bottom pools along with L. semiplena; this last was common on the reef at the beach line. Oxyrrhis marina, a pigmented dinoflagellate, and naviculoid diatoms were present among the filaments.

The inner zone of the reef flat itself looked barren and when dry was the color of the sand. Closer inspection showed a solid turf of a fine red alga almost completely covered with fine silt. Green algae grew around the edges of the pools shaded by the overhanging sides and on the underside of stones in the pools. The bottoms of many of these pools were usually scoured clean of algal growth. This type of reef extended to about the 250 foot quadrat.

The second zone of the reef had a predominantly green aspect from a distance and started roughly at the 300 foot quadrat. At low tide this part of the reef showed an almost continuous series of tide pools and standing water. Considerably more water was present here at low tide than on the reef at either side. Dictyosphaeria and Cladophoropsis were the common algae present, covering the flat itself and showing the darkest green around the edges of the pools and under the shaded overhang of projections. Jania capillacea made its appearance in this zone. Much fine silt was caught in the algal turf. The outer border of this reef zone merged with the next zone between 450 and 500 feet.

The third zone was red in color and extended to the coralline ridge at 600 feet. It was covered almost continuously with Jania decussatodichotoma. The Jania cover became heavier in the back-ridge trough which was filled with water continuously. Fleshy gelatinous red algae grew at the base of the Jania. Very few green algae were present, usually only Dictyosphaeria. A branched coralline alga, Goniolithon, occurred in the wider parts of this zone and sometimes formed solid stands. The outer edge of this zone was irregularly defined by the surge channels and mounds that extended back from the ridge itself.

The coralline ridge formed the outermost zone and was continually washed and battered by the heavy surf. This ridge was most spectacular in appearance, extending in each direction as far as the eye could see. Setchell (1924: Veg. of Rose Atoll, Car. Inst. Pub 341:243) quotes the Funafuti report in which this spectacular Onotoan reef was described. The same species that form the reef here at Onotoa, occur on Rose Atoll.

The ridge front was covered completely with a smooth pink crustose coralline alga, probably Porolithon onkodes. The ridge was broken by long, smooth-walled surge channels, 4 to 5 feet deep and gradually becoming shallower, ending in the back ridge trough. Each wave hitting the front of the ridge sent a rush of water up these surge channels into the back ridge trough. Alternating with the surge channels were dividing mounds 3 to 4 feet higher than the general elevation of the reef. These mounds were covered by upright pinnacles of Porolithon craspedium f. mayorii, pink in color, but fading to white on drying. Jania covered the base of the ridge as a short turf and also grew around the bases and between the blade-like projections of the Porolithon craspedium. Caulerpa urvilliana occasionally grew on the slope of these mounds. Very few of the cushiony greens occurred here. Dictyosphaeria setchellii grew along the surge channels. On the smooth shaded walls of the channels Rhipilia orientalis was inconspicuous, but common. Here is another example of the distribution mentioned by Doty (1954, p. 367) where the genus Rhipilia occurs on an atoll in the absence of the genus Sargassum.

Records for the square foot quadrats.

1. Beach line. (8123). Algal felt was scanty and short, giving barely any color to the reef surface. The bottoms of the pools at this level

were scoured clean. The dominant algal forms were small soft tufts with much sand intermingled, and these were identified as Schizothrix cresswellii and Lyngbya semiplena. A prolific branched species of Enteromorpha was fairly common.

2. Transect at 50 feet. (8124). A reddish color was observed on the reef flat here and the turf was more or less continuous. An alga tentatively identified as Pterocladia formed this reddish turf which was 8 to 10 mm. tall. Only the ends of the filaments protruded from the fine silt. Dictyosphaeria and Cladophoropsis, the green algae present, grew around the edges of tide pools. Small amounts of Jania capillacea grew in the cushions of the green algae. A Chroococcus-like blue-green alga formed dense mats around other algae.

3. Transect at 100 feet. (8125). The flora was much the same as described for the 50 foot transect. The growth of Pterocladia and the green algae bordering the tide pools was heavier. Porolithon onkodes encrusted pebbles in the tide pools.

4. Transect at 150 feet. (8126). Pterocladia was still present giving a reddish color to the reef flat. Cladophoropsis and Dictyosphaeria grew into huge cushions forming a solid ring around tide pools. Lyngbya sordida grew along the edges of these pools. Jania was growing mixed with Cladophoropsis.

5. Transect at 200 feet. (8136). Traces of Pterocladia were still present on the reef flat, but Cladophoropsis was dominant, extending out over the reef flat from the edges of the tide pools. Other species present as described in 150 foot transect.

6. No sample at 250 feet.

7. Transect at 300 feet. (8137). Species of green algae, Cladophoropsis, Boodlea and Dictyosphaeria completely encircled the pools and covered most of the reef flat. Red algae were very scarce at this station on the reef. Porolithon pebbles were present in the tide pools.

8. Transect at 350 feet. (8163). The turf covering the reef here was very short. Water covered most of this section of the reef at low tide. In addition to the species present at 300 feet, Jania capillacea was the dominant red alga present and grew over and mixed with Boodlea.

9. No sample at 400 feet.

10. Transect at 450 feet. (8164). The general aspect of the reef was still green at this station. The reef flat was dry here at low tide, but there were many tide pools filled with water. Green species were present as above. Laurencia, bleached yellow, was common in the tide pools. Crustose corallines were more common. Two species of Jania were abundant, with J. decussato-dichotoma the common species. An occasional specimen of Porolithon gardineri was found in this area.

11. Transect at 500 feet. (8168). The predominant color of the reef from this point to the surf line was red. Jania decussato-dichotoma was the dominant alga here on the reef flat. Laurencia was also common. Boodlea, Cladophoropsis and Dictyosphaeria grew around the edges and in the bottom of the tide pools.
12. Transect at 550 feet. (8169). Jania decussato-dichotoma had almost 100% cover at this station. A large species of Laurencia was present and a few small plants of Dictyosphaeria. Centroceras clavulatum was growing on the Laurencia. Goniolithon frutescens first appeared on the reef at this point.
13. Transect at 600 feet. (8170). The back ridge trough started at this quadrat. The reef flat was almost completely covered with an entangled growth of Jania and the branching coralline Goniolithon. The Laurencia growing here was frequently covered with epiphytic diatoms Licmophora and Cocconeis.
14. Transect at 650 feet. The coralline ridge constituted the outer zone of the reef and has been described above.

Table 1. Distribution of algae on the seaward (windward) reef.

Algae	Beach	Distance from beach (feet)											
		50	100	150	200	300	350	450	500	550	600	650	
<i>Lyngbya semiplena</i>	D	t											
<i>Schizothrix cresswellii</i>	D												
<i>Enteromorpha</i> sp.	D												
<i>Cladophoropsis</i> sp.		P	P	P	D	D	P	P	t				
<i>Dictyosphaeria</i> spp.		P	P	t		D	P	P	P	P	t		
<i>Pterocladia</i> sp.		D	D	D	t	t							
<i>Jania capillacea</i>		t	t	P	P		P						
<i>Porolithon onkodes</i>			P	P	P	P	P		P	P	P		
<i>Lyngbya sordida</i>				P									
<i>Laurencia</i> spp.				t				D	D	D			
<i>Boodlea</i> sp.							P	P	P				
<i>Jania decussato-dichotoma</i>						t	P	D	D	D		P	
<i>Porolithon gardineri</i>							P	D					
<i>Goniolithon frutescens</i>								P					
<i>Porolithon craspedium</i>									P				
<i>Caulerpa urvilliana</i>												D	
<i>Rhipilia orientalis</i>												P	
<i>Polysiphonia</i> sp.									t	t	t	t	

Key: D-dominant species. P-present in fair quantity. t-traces only.

ALGAE

Tentative Species List

Lyxophyta

Identification to species in this group were made by Dr. Francis Drouet, Chicago Museum of Natural History.

Anabaena sp.

North Island 8325.

A few filaments were found growing in a mat of Rhizoclonium hieroglyphicum on the sandy surface of a babai pit.

Anacystis dimidiata (Kütz.) Dr. & Daily

North Island 8166, 8345, 8346.

A member of the algal flora in the babai pits around the base of the Eleocharis plants. This species was also found in the thick mat on the surface of the brackish pools in the "caliche" soil area. This mat was orange in color on top, but olive-green below. It was also present in the granular bottom scum of these same pools. Other algae present in these mats were A. montana, Coccochloris stagnina, Lyngbya versicolor, L. aestuarii, L. guaymensis.

Anacystis montana (Lightf.) Dr. & Daily

North Island 8345, 8103; South Island 8216, 8217. Tabuarorae 8236.

This species was present as part of the flora in the mat on the surface of the brackish pools. It also occurred with Scytonema hofmannii on bare sandy areas between large coral fragments on the exposed northern tip of North Island. Blue green algae collected from coconut and Pandanus logs also contained this species associated with S. hofmannii.

Calothrix pilosa Harv.

Lagoon beach 8182, 8393.

A spongy mass on the beach and on beach rock at the high tide line; the collections were made at the north end of the lagoon near the village of Teneang. Growing here with other blue greens.

Coccochloris stagnina Spreng.

North Island 8324, 8345, 8346; Tabuarorae 8242.

One of the species common in the flora at the bottom of the babai pits, in one case associated with Plectonema nostocorum. This species was also found as a member of the floating mat described under Anacystis dimidiata.

Entophysalis conferta (Kütz.) Dr. & Daily

North Island 8064

Growing in the middle tide pools of the beach rock outcrop on the seaward side of the North Island at the camp site. These are the tide pools studied in respect to their pH and temperature, as reported by Cloud (Atoll Res. Bull. #12, 1952). This species also covered the beach rock and gave it a bluish color, (see Newhouse, 1954. Atoll Research Bull. #33: 53). Other species present in the tide pool were Lyngbya confervoides and L. semiplena.

Entophysalis crustacea (J. Ag.) Dr. & Daily

North Island 8182.

Found covering the beach rock at high tide level in the lagoon near the village of Teneang. Associated with Calothrix pilosa and other blue greens.

Entophysalis deusta (Menegh.) Dr. & Daily

North Island 8183.

Growing on beach rock at high tide level, 100 feet from shore. Same area as E. crustacea.

Fischerella ambigua (Nag.) Gom.

North Island 8144.

Found on the soil at the top edge of a babai pit. Associated with Scytonema hofmannii.

Hydrocoleum floccosum (Hauck.) Gom.

Lagoon 8190.

Growing on the bottom of the lagoon and covered at low tide. Common at the shore end of the Thalassia beds (turtle grass).

Lyngbya aestuarii Gom.

North Island 8119.

A member of the community of algae in the scum on the brackish pools. See Anacystis.

Lyngbya confervoides Ag.

Lagoon 8026, 8028, 8182; North Island 8064.

Growing on the lagoon reef flat at the south tip of North Island, at low tide level about 100 feet from shore. The fur of filaments had become filled with fine lime silt, so that only the tips showed above the loose mass. This condition was noticed at other places over the lagoon bottom. This species was also a member of the flora in the middle tide pools of the beach rock on the seaward side of North Island. It was found associated with Entophysalis crustacea on beach rock in the lagoon. At one site this species formed a dark blue green stratum about $\frac{1}{4}$ of an inch below the surface of the soft beach rock.

Lyngbya guaymensis Dr.

North Island 8119, 8345.

A member of the floating mat community in the brackish pools. See description under Anacystis dimidiata.

Lyngbya meneghiniana (Kütz.) Gom.

North Island 8350.

A member of the flora growing in the lowest tide pools in the beach rock on the seaward side of North Island.

Lyngbya semiplena Gom.

North Island 8064, 8067; seaward reef 8123.

A member of the algal community from the middle tide pools of the beach rock on the seaward side of North Island. With Entophysalis conferta and Lyngbya confervoides. In the first of a series of transects scraped from the seaward reef, this species with Schizothrix cresswellii were members of the algal felt covering the reef at beach level.

Lyngbya sordida (Zanard.) Gom.

Seaward reef 8390C, 8482C.

This plant was present in the tide pools of the green algal zone of the seaward reef, associated with Dictyosphaeria.

Lyngbya versicolor Gom.

North Island 8119, 8345, 8346.

This species was growing in the floating mat community and in the granular bottom deposits in the brackish pools of the "caliche" area. See under Anacystis dimidiata.

Merismopedia sp.

North Island 8166.

In the material collected from the babai pits a few specimens of this genus were found.

Microcoleus chthonoplastes (Fl. Dan.) Thur.

North Island 8134, 8473; lagoon 8180.

One of the algae present in the soil community of the old dune sands of the rampart on the seaward side of North Island. Growing with Scytonema hofmannii. It was also found on the lagoon beach.

Nostoc muscorum Ag.

Lagoon 8179.

Occurring on exposed, incipient beach rock of the lagoon at low tide level, with Scytonema hofmannii.

Nostoc sp.

North Island 8320, 8322.

Young material was growing on the soil of a path in the center of North Island in a community including Schizothrix heufleri and Scytonema hofmannii. Drouet reports that the material in 8322, which was associated with a moss, was parasitized.

Oscillatoria nigro-viridis (Thur.) Gom.

Lagoon 8182B.

This species formed a light green stratum in beach rock at high tide level in the lagoon at the profile studied at the village of Taneang, North Island. Here it was associated with Lyngbya, Calothrix and Phormidium valderiarnum.

Phormidium crosbyanum Tild.

Bikati Island, Big Makin Atoll, Gilbert Islands 8009.

This species covered the coral rocks and lined the depressions on the reef at high tide level.

Phormidium valderiarnum Gom.

Lagoon 8182B.

Associated with Oscillatoria nigro-viridis which see.

Plectonema nostocorum Gom.

Tabuarorae 8242.

This alga was present in the mat in the bottom of an abandoned babai pit, growing with Coccochloris stagnina around the stems of Eleocharis.

Schizothrix cresswellii Haw.

Seaward reef 8123.

With Lyngbya semiplena, growing in the first transect of algae scraped from the seaward reef at beach level.

Schizothrix friesii (Ag.) Gom.

North Island 8111, 8285, 8321; Tabuarorae 8240.

Covering the soil (silty loam) on paths, in the sun as well as in the shade. It was also collected on the beach rampart. Most frequently it was associated with Scytonema hofmannii.

Schizothrix heufleri Grun.

North Island 8320.

The skin-like coating on the soil surface of a path in the center of North Island was formed by this alga and two associates, Scytonema hofmannii and young Nostoc.

Scytonema guyanense (Mont.) Born. & Flah.

North Island 8118.

This species was growing on the roots of a fallen coconut tree.

Scytonema hofmannii Ag.

North Island 8103, 8134, 8144, 8160, 8285, 8321, 8322, 8473; lagoon 8179; South Island 8215, 8217; Tabuarorae 8236.

The common blue green alga of the soil community, it was found growing on the paths, roads, seaward rampart and logs. It also occurred in the babai pits. Only one collection was found on the beach rocks in the lagoon, where it was associated with Nostoc muscorum. In the soil collection it grew with a wide variety of blue greens including the following genera: Anacystis, Fischerella, Microcoleus, Nostoc and Schizothrix.

Scytonema ocellatum Lyngby

North Island 8096; Tabuarorae 8241B.

The black tufts of this alga resembled the moss plants with which it grew. It was found on lime sand soil along the lagoon road, usually in deep shade.

Chlorophyta

Avrainvillea sp.

Western Reef 8443.

This is probably A. nigricans Dec. but final determination has not been made. Growing in 5 feet of water attached to coral rocks. The plant was $4\frac{1}{2}$ cm tall.

Boodlea sp.

Seaward reef 8137, 8163.

Scattered plants of this unidentified Boodlea grew on the seaward reef. This area was dry at low tide except for the tide pools which were usually clear of algae. In the preliminary survey of the algal belt scraped from the seaward reef this species was found sparingly in the 300-foot transect along with other green algae, but in the 350-foot transect it formed a turf overgrown with Jania capillacea.

Boodlea vanbosseae Reinbold.

Lagoon 8421.

This species grew on the flats at the northwest corner of the atoll and was exposed at low tide. It was growing with Ceramium and Polysiphonia.

Bryopsis pennata Lam.

Lagoon 8354.

The only specimen of this plant that has been found in the collections so far was a thick mat washed up on the lagoon beach.

Caulerpa elongata Weber Van Bosse.

Lagoon 8260, 8261, 8263, 8401, 8452.

This species of Caulerpa was confined to the western side of the lagoon. All but one specimen were attached tightly to coral rocks. The exception was found growing on Valonia aegagrophila, which was attached to coral rock. Both f. typica and f. disticha were recorded. Because of its

small size this species may have been overlooked frequently.

Caulerpa serrulata (Forssk.) J. Ag.

Lagoon 8052, 8425; Betio, Tarawa Atoll 8624.

The specimens assigned to this species were confined to shallow water in the central part of the Onotoa lagoon on lime sand bottom. It also grew in the Thalassia patches of the north central lagoon. The Tarawa specimen was collected on the western seaward reef of Betio.

Caulerpa urvilliana Mont.

Lagoon 8029, 8052, 8249, 8235A, 8317, 8408, 8409, 8425, 8433.

West reef at Aonteuma 8100; flat, east of Aonteuma 8423.

Water-way between islands 8143, 8445; seaward reef 8174, 8188.

The commonest species of Caulerpa on the atoll. It grew in shallow waters, uncovered at low tide, down to a depth of 14 feet. It was present in the patches of Thalassia in the lagoon. The isolated patches of coral in the flowing water between the islands had growths of this Caulerpa on them. It was attached by the root-like structures of the horizontal rhizoid to coral rock, lime sand, living blue coral and the coralline algae crust of the seaward ridge. Wherever it grew the habit of the plant tended to cause the deposition of silt. Microdictyon and many small red algae grew upon it as epiphytes.

Chaetomorpha sp.

Lagoon 8475.

A species assigned tentatively to this genus was found growing on the bottom of one of the boats we used for survey work in the lagoon. The boat had been in the lagoon water continuously from June 30th to August 28th. Enteromorpha was also present.

Cladophoropsis sp.

Seaward reef 8136, 8137.

A member of the green algal community on the seaward reef. It was the dominant species at 200 feet from shore, but codominant with Dictyosphaeria at 300 feet.

Dictyosphaeria sp.

Seaward reef 8164; lagoon 8026, 8263.

The specimens have not been determined to species at the time of this writing. The specimen from the seaward reef was growing at 450 feet from shore and was not abundant. The other specimens were found on a reef

flat, 100 feet from shore just at low tide level. Also growing with Valonia on coral rocks on the lagoon side of the western reef.

Dictyosphaeria cavernosa (Forssk.) Borg.

Seaward reef 8137, 8390, 8482B; lagoon 8278, 8309, 8456, 8479, 8421; Betio, Tarawa Atoll 8632.

The common species of Onotoa Atoll. An abundant plant on the seaward reef, codominant with Cladophoropsis at 300 feet from the shore. It was common in the lagoon on coral knolls and rocks to a depth of 10 feet. Many of the hollow globular plants had split open into irregular flat masses. Collected also on the seaward reef of Betio Island, Tarawa Atoll.

Dictyosphaeria intermedia Weber Van Bosse

Seaward reef 8163, 8390B; reef flat northwest corner of Atoll 8421.

This species grew on the seaward reef at 350 feet from shore. It occurred also on the vast flat at the northwest end of the atoll where it was exposed at low tide. There are many collections of this genus remaining to be determined so other examples of this species will no doubt be found.

Dictyosphaeria setchellii Borg.

Seaward reef 8045.

This species has been found only once in the collections examined to date. It was collected on the ridges between the surge channels on the seaward reef. Here the surf washes over it even at low tide and it is never completely dry. Trabeculae inside the cells were many and measured 100 to 118 microns in length. Some of them were forked.

Enteromorpha sp.

Lagoon 8475.

An undetermined species was collected on the bottom of one of the boats used in the lagoon. See under Chaetomorpha. This species of Enteromorpha is only slightly branched.

Enteromorpha compressa (L.) Grev.

Lagoon 8181.

This Enteromorpha was growing at the base of the beach rock at high tide level in the lagoon, at the village of Taneang. A detailed paper analyzing the Halimeda is in manuscript and will be published separately soon.

Halimeda opuntia (L.) Lam.

Western Reef 8115B, 8249, 8249B, 8256A, 8256B, 8257, 8258, 8272A;
lagoon 8318, 8398A, 8441, 8471; seaward reef 8478.

The most common and widely distributed species on the atoll. Most of the collections were from the western reef or coral knolls along the western side of the lagoon. Only one specimen was collected on the windward or seaward reef and it had been washed into a tide pool. Never abundant but generally growing in small patches or in a circle, turf-like, around the bases of the coral knolls, from just below the surface to a depth of 6 meters.

Halimeda bikinensis W. R. Taylor

Lagoon 8467.

This species described by Taylor (Plants of Bikini, University of Michigan Press, 1950) from Bikini was collected at only one location, in the deepest part of the lagoon, opposite the village of Aiaki, South Island. The bottom here was lime mud and sand. The depth of water was 48 feet.

Halimeda fragilis W. R. Taylor

Lagoon 8246, 8265, 8438; western reef 8272B.

This species was also first described by Taylor from Bikini. Specimens were collected from the western reef on both the lagoon and seaward side, and on coral knolls. It was found growing in water 3 to 12 feet deep, on lime sand and coral rock bottom.

Halimeda orientalis Gilbert

Lagoon 8409.

Apparently rare since only one collection was made. This was found in the western side of the lagoon between the reef Rakai Taka and Rakai Ati in 3 feet of water.

Halimeda stuposa W. R. Taylor

Western reef 8115; sand flats of Aonteuma 8113, 8481; lagoon 8221, 8277, 8359A, 8426.

This species was very abundant in the shallow sandy north portion of the lagoon and on the shallow sandy windward reef flats extending north east from Aonteuma. Fairly common in the shallow area covered with Thalassia. In many of these habitats the plants were partly or entirely exposed at low tide. One collection was made on the leeward reef west of Aonteuma Island, in a surge channel.

Halimeda taenicola W. R. Taylor

Western reef 8116, 8270; reef flat northeast of Aonteuma 8434.

This large and heavily calcified species was found growing on the leeward reef in surge channels and holes in the reef. Most of the specimens collected were in 6 to 11 feet of water. Found growing with H. opuntia.

Halimeda tridens (Ellis & Solander) Lamouroux f. tripartita (Barton) Collins.

Western reef 8271; lagoon 8468.

Not a common species. Found in the deepest part of the lagoon at 48 feet with H. bikinensis, and on the seaward edge of the leeward reef in 6 to 11 feet of water.

Microdictyon sp.

Lagoon 8263; tide pool, seaward reef 8478.

Much of the Microdictyon collected remain to be determined. These algae were very common along the shore of the lagoon and in the Thalassia beds. Specimen 8263 was growing on coral rocks with Valonia in the western area of the lagoon. Number 8478 was collected from a tide pool on the seaward reef with blue green algae.

Microdictyon umbilicatum Velley.

Lagoon 8409.

Growing with Halimeda in the western area of the lagoon.

Rhipilia orientalis A. and E. S. Gepp

Seaward reef 8370, 8380.

Fairly common as a fungus-like growth on the smooth walls of the surge channels on the seaward reef in shaded situations. Exposed at low tide only between waves. Polysiphonia was epiphytic on these plants.

Rhizoclonium hieroglyphicum (Ag.) Kütz.

North Island 8046, 8135, 8166, 8325.

A common member of the freshwater algal community in the babai pits, sometimes forming huge mats covering the entire surface. At other times mixed with the blue greens present. Also found growing in one of the freshwater wells where the water level was 15 feet below the soil surface.

Valonia aegagrophila C. Ag.

Lagoon 8263; seaward reef 8287.

One collection was on coral rocks on the lagoon side of the western reef. The other was growing nearly 300 feet from shore on the seaward reef, mixed with other algae in the turf covering the reef.

Pyrrophyta

Exuviella sp.

Present in masses of Cladophoropsis and blue greens examined under the microscope at the time of collection.

Chrysophyta

(Diatoms)

Cocconeis sp. Present as an epiphyte on other algae growing at 600 feet from beach on seaward Transect A.

Licmophora sp.

A very common epiphyte, especially on material collected in August. Found growing on Laurencia, Ceramium and other algae on the seaward reef and in the back-ridge trough of this reef. Also common on algae collected from the lagoon.

Podocystis sp.

An occasional epiphyte on other algae.

Striatella unipunctata (Lyngbye) Agardh

Noticed as an occasional epiphyte on Jania and other red algae.

Unidentified diatom

An unidentified epiphyte covered plants of Dasya (8264) and Polysiphonia collected on the lagoon side of the western reef.

Euglenophyta

Euglena spp.

North Island 8138, 8166.

An uncommon member of the algal community in the bottom of the babai pits. With Anacystis and Phacus.

Phacus pleuronectes (O.F.Mull.) Duj.

North Island 8138.

The dominant organism present in water collected from the bottom of one of the babai pits. Euglena and a few ciliates the only other organisms present.

Phaeophyta

Turbinaria ornata J. Ag.

Seaward reef 8017, 8032, 8122, 8482A; lagoon 8075, 8221, 8276; reef flat northwest corner of atoll 8421; Rogeron Island, Majuro Atoll, Marshall Islands 8004.

The specimens from the seaward reef were picked up in the wash on the beach and probably came from beyond the coralline ridge, since this species did not occur on the reef flat itself. The only fertile specimen came from the seaward reef. The lagoon specimens were growing in irregular patches on coral fragments in $4\frac{1}{2}$ feet of water, 200 feet from shore. The specimens from the reef flat at the northwest end of the atoll were growing exposed at low tide.

Padina sp.

Collected from the seaward reef (western reef) of the Island of Betio, Tarawa Atoll in September on the return trip. This alga was noticed as very common at the landing on Majuro, Marshall Islands, but not collected. Missing from the flora of Onotoa.

Rhodophyta

Ceramium sp.

Noticed as one of the fine epiphytic algae growing on many of the larger algae on the seaward reef and in the lagoon.

Centrocerus clavatum (C. Agardh) Montagne

Seaward reef 8289.

Growing epiphytically over Laurencia and Jania on the outer end of the seaward reef. This species, occurring very commonly as a fine fuzzy epiphytic growth tightly attached and intertwined, was found in examining many other algae.

Dasya sp.

Lagoon 8261, 8264.

The two specimens above after preliminary examination seem to belong to this genus. Both grew on coral rock in the western side of the lagoon and were associated with Caulerpa and Polysiphonia.

Dictyurus purpurascens Bory

Reef northeast of Aonteuma 8358; reef shoals outside coralline ridge 8458.

One specimen was growing in water 8 feet deep at low tide and was growing in a hole in a coral head. The other on coral rock outside the coralline ridge on the seaward side of North Island.

Jania sp.

Lagoon 8026; seaward reef 8164, 8289.

These specimens have not been satisfactorily determined at the present writing. The one from the lagoon grew on a reef flat at the south end of North Island and was exposed at low tide. The other two were collected with Laurencia and Centrocerus on the outer end of the seaward reef in the red algal zone.

Jania capillacea Harvey

Seaward reef 8136, 8163, 8164, 8287.

A very common member of the algal turf community on the seaward reef. It first appeared in collections at 200 feet from shore, attached to Cladophoropsis. It became dominant at 350 feet. It was less common at 450 feet where it was growing on Laurencia. The following species of Jania replaced it here in abundance.

Jania decussato-dichotoma (Yendo) Yendo

Seaward reef 8163, 8164.

This species first appeared on the seaward reef at 350 feet from shore and became the dominant form of Jania on the outer end of the reef from 450 feet to 600 feet. At 450 feet it shared dominance with Laurencia, while from 500 to 600 feet it grew on and over the crustose Porolithon onkodes.

Laurencia sp.

None of the members of this genus have been determined to species at this writing.

Lagoon reef flat 8026; seaward reef 8164, 8287, 8289, 8367.

In the lagoon this alga was growing on the reef flat at the south end of North Island in pools and in some cases partly exposed at low tide. It grew on the seaward reef from 450 feet to 600 feet from shore associated with Jania, Valonia, Centrocerus. In August it was covered with epiphytic diatoms of the genus Licmophora. It was a dominant member of the reef flora at 450 feet. Several species are represented by the collections.

Polysiphonia sp.

Lagoon 8026.

The species of Polysiphonia examined to date are sterile and have not been determined to species. The genus grows as part of the filamentous fuzz on larger algae such as Laurencia, Caulerpa, Jania, and Dasya.

Porolithon gardineri (Foslie) Foslie

Seaward reef 8164.

The determination of the coralline red algae remains to be done. The two specimens identified tentatively as this species were collected in the one square foot transect on the seaward reef at 450 feet.

Porolithon onkodes (Heydrich) Foslie

Seaward reef 8136, 8137, 8163.

Only a tentative identification of this crustose alga. Found growing on pebbles in the tide pools of the seaward reef at 200, 300, and 350 feet from shore. Presumed to be the pavement crust at 550 feet and out over the coralline ridge.

Porolithon craspedium (Foslie) Foslie

Coralline ridge 8371, 8372.

The dominant coralline on top of the ridges separating the surge channels. Blue green algae, possibly an Oscillatoria, and Jania growing down in the creases between the blade-like structures.

Pterocladia sp.

The shoreward edge of the seaward reef is covered by a short red alga with only the bleached tips showing above the silt. After preliminary examination of this plant I have tentatively placed it in this genus. It is the dominant member of the algal community on the reef from 50 feet to 100 feet and is associated here with a few plants of Cladophoropsis.

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The Maldive Islands, Indian Ocean

by

F. R. Fosberg

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THE MALDIVE ISLANDS, INDIAN OCEAN

by
F. R. Fosberg 17

Along the west coast of India and extending far south beyond the tip of peninsular India and across the equator stretch two long chains of atolls, the Laccadive group to the north and the Maldives to the South, with the isolated Minicoi Island between the two. These islands have been surveyed and described in the literature perhaps more thoroughly than most Pacific groups, as will be seen in examining the index to the Atoll bibliography in Island Bibliographies (Sachet and Fosberg 1955). Some historical and scientific highlights among the published works on the Maldives may be briefly recalled here.

In 1854-58, C. Defrémery and B. R. Sanguinetti published a French translation and edition of the voyages of Ibn Batūtah, an Arab voyager who visited the Maldives around 1343, lived there for a while, and gave an extremely vivid account of the islands and of life on them. This work has been considered the earliest descriptive account of the Maldives, and the manuscript may also be the earliest description of an atoll group. There are earlier references to these islands in ancient literature, but probably no detailed account.

A Frenchman, Pyrard de Laval, lived in the Maldives in the first years of the 17th century, after the ship Corbin, on which he travelled, was wrecked in 1602. His narration of his adventures is one of the most delightful travel accounts ever written, and includes much valuable information on the Maldives and their inhabitants.

Another "first", of course, for the Maldive group is the fact that the word atoll, or atollon, originated there. In this connection, a little-known paper by a French Navy officer may be of interest. In a letter to his former superior on the Corvette la Coquille, Commander L. I. Duperrey, with whom he had visited many Pacific Island groups, J. de Blosseville mentioned his visit to the Maldives in 1827 while serving on the Corvette la Chevrette. He wrote (1828, p. 700) "Vous vous rappelez sans doute que nous avons souvent parlé des rapports qui devaient exister entre les Atollons des Maldives et les groupes d'îles basses de la Polynésie; les traits de ressemblance sont parfaits, et je persiste à croire que la désignation de ce genre d'îles sous le nom d'Atollons, jetterait une grande clarté dans la nomenclature en devenant générale." Whether or not this young man was the first person to make this suggestion is not so important as the fact that our commonly used term for ringed-shaped low coral islands came from the Maldivian language and was generalized by observant voyagers more than a hundred years ago.

Some historical and other information on the Maldives is summarized in a work compiled by Bell (1883). From the point of view of natural

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history, besides the observations by Agassiz, Sewell, and others, the largest single contribution is J. Stanley Gardiner's monumental monograph: The fauna and geography of the Maldive and Laccadive Archipelagoes, 1901-1906, and other papers resulting from his work there. An account of the flora was published by J. C. Willis and J. Stanley Gardiner in 1901, extracts from which are given below in the list of plants.

Brief Report on a Trip to Malé Atoll, Maldives

There has been little of a scientific nature published on the Maldives since the results of the investigations of Prof. J. Stanley Gardiner mentioned above. Therefore, it seems worth while to place on record an account of a brief visit to Malé in April 1956, made possible through the courtesy of the government of His Highness Ali Amir Mohammed Farid Didi, Sultan of the Maldives and by financial aid from the Pacific Science Board. My sincere gratitude is expressed to the Hon. Philip K. Crowe, then U. S. Ambassador to Ceylon, for placing me in contact with the Maldivian authorities; to His Excellency, Ibrahim Ali Didi, Prime Minister of the Maldives, for an invitation to visit Male as a guest of the Maldivian Government, for courtesies and comforts extended to me while there, and for much information on the Maldives; to Messrs. Lajeki Ebrahim Didi, U. Abdullah, Adnan Husain, and Farouk Ismail, all of Malé, for many kind attentions and much information on the Maldives; and to Capt. H. Bloch, of M. S. Hugo Arlt, for many courtesies and pleasant company during the voyage from Colombo to Malé and return.

Malé is a large atoll lying north of the center of the Maldivé Archipelago, about 470 miles WSW of Colombo, Ceylon. Malé Islet, the principal islet and capital of the group, lies on the southeast corner of the atoll, at Lat. $4^{\circ} 10' N$, Long. $73^{\circ} 30' E$. It has an area of about one-half square mile and a population of approximately 8,000; the total population of the archipelago is about 87,000.

Departure from Colombo aboard M. S. Hugo Arlt was early on the morning of April 8, 1956. During the voyage the sea was calm and the sun hot, but there was little breeze; the temperature dropped somewhat at night. We sighted Malé Atoll on the morning of April 10 and anchored in the lagoon about the middle of the forenoon. The Hugo Arlt carried a cargo of rice, flour, and other supplies for Malé, and was to pick up "Maldivé fish", a special sort of dried bonito, to take to Ceylon.

The islets of Malé Atoll, seen on approaching and entering the lagoon, are mostly, with the exception of Malé itself, well covered by coconut trees, with some lower marginal forest at the tops of the beaches. Hululé Islet, immediately north of Malé, has a conspicuous road cut through the coconuts for its full length. A feature different from most Pacific atolls is the number of islets scattered within the lagoon, in addition to those along the peripheral reef. All except some very small ones are covered by coconut groves, surrounded, or partially so, by trees of several kinds. The outer reef on both sides of the channel is broad

and its outer edge is exposed at mid-tide. This outer margin, however, is of brownish rocks, not the pink algal ridge common on Pacific reefs. Except for this margin a few yards wide, the reef is covered with water up to the beach. A pale greenish color suggests that the reef flat is generally sandy.

The first close-up view of Malé Islet is a distinct surprise to one familiar only with Pacific atolls. Almost the entire islet is surrounded by a low stone wall. White stone buildings of two and even more stories dominate the lagoon shore. Centrally located is an ancient stone fort, said to be of Portuguese construction. Along the entire lagoon shore, enclosing a busy inner boat harbor, is a sea-wall of stone carefully laid but without mortar. This wall is necessary to protect the boats against the rough water of the lagoon during the monsoon season. During my visit, however, the lagoon surface remained like a sheet of glass. The wall is said to be 300 years old, and is in excellent shape though it requires annual repairs after battering by lagoon waves during the monsoon. Just outside the sea-wall the bottom drops off abruptly to 30 fathoms. This depth extends for some distance, to near the first lagoon islets, and provides an excellent anchorage for the Maldivian schooners and "bugaloes" as well as for visiting steamers such as the Hugo Arlt. Loading and unloading of steamers is by lighter.

Visitors are taken ashore in smartly rowed boats, conducted to the customs house, and treated with a quiet unfailing courtesy and hospitality that could serve as an example for officials of any country. One of the conspicuous features of the entire visit was the general kindness and friendliness of everyone, from the Prime Minister to the child on the street or the boatman in the harbor. Another was the complete lack of women in the crowds on the streets. In striking contrast to Ceylon, the only glimpses of Maldivian women were caught when an occasional attractive brown face peeped over the walls that line all the streets. Still another feature, notable in an Asiatic city, was the spotless cleanliness to be observed everywhere. Even Holland could do little more than match it. This cleanliness applied, so far as could be seen, to the streets, the shops, the houses, the courtyards and to the white blouses and sarongs with which most of the people were clothed.

The entire islet of Malé, except the green, or playing field on the east end and several parks or squares, is laid out in geometrically straight streets lined with stone or masonry walls about head high. Inside the walls and extending above them is a profusion of trees and ornamental shrubs of many kinds. The parks show a neatness and order that is comparable with that of a European formal garden. The green smooth lawns are not of grass but of the creeping hardy Lippia nodiflora, with bright green leaves and heads of tiny white flowers. Shrubs with bright flowers or colored foliage are planted as though laid out with the aid of surveying instruments. The court-yards of the houses are covered by a smooth layer of coarse white sand, largely made up of joints of the articulated calcareous green alga, Halimeda. This special sand is said to be collected on the beaches of some of the other islets at particular seasons when the waves wash it up.

An unusual feature of Malé is the large variety of cultivated plants, some of them scarcely expected on a coral atoll. It seems probable that one factor favoring some of them is the prevalence of walls that provide shelter from salt spray driven by the monsoon and storm winds. Coconut trees are relatively few on Malé Islet, itself. Breadfruit, mango, Thespesia, and Hibiscus tiliaceus are the most common trees. Inside the walls weeds seem to be nonexistent. Anything that grows is there because it is planted and permitted to grow. Botanizing for spontaneous plants is a fruitless pursuit except on the narrow flat strip outside the wall and on an unexpected tiny meadow-like area within the ramparts of the ancient fort. On these bits of relatively unused land small areas of well-trampled sod, scattered strand plants, weeds, clumps of bushes, and even a small thicket of an unpleasantly spiny Pandanus manage to maintain themselves. On the south side is a flat of broken coral pebbles and cobbles with very little vegetation. Familiar plants, to one used to Pacific atolls, found in these places include Scaevola sericea, Premna obtusifolia, Terminalia catappa, Morinda citrifolia, Eleusine indica, Fimbristylis cymosa, Tridax procumbens, Paspalum vaginatum, Eragrostis anabilis, Euphorbia hirta, Vernonia cinerea, Ochrosia oppositifolia, Guettarda speciosa, Clerodendrum inerme, Thuarea involuta, Wedelia biflora, Portulaca oleracea and many others. Other species are either quite unfamiliar or found chiefly on high islands in the Pacific. In the latter category are Turnera ulmifolia, Alysicarpus vaginalis, Indigofera tinctoria, Calotropis gigantea, Thespesia populnea, Lippia nodiflora, and Acalypha lanceolata. A full list of plants collected or seen, both wild and planted, is appended.

The only wild birds seen on Malé Islet were occasional crows, similar to those seen in Ceylon, and two individuals of a kind of large heron. Chickens, rats, cats, and three or more species of lizard were seen. Curiously, the Maldivian language is said to have no word for lizard, though they are common and conspicuous. Mosquitoes of at least two, and probably more, species are abundant. Both day- and night-biting kinds were found. A few flies were noticed.

During the three days on the atoll scarcely a breath of breeze stirred, and the heat was terrific, moderating only a little at night. This weather was said to be unusual and the monsoon was expected shortly.

A visit was made to two islets of Malé Atoll other than Malé itself. These were both uninhabited except for custodians who look after the coconut plantations and harvest nuts. One of these was Kuda Bados Islet, in the lagoon, the other was Furannafuri Islet, on the east reef, the third fairly large reef-islet north of Malé. These islets were fairly different in their physical aspect, but whether typical, respectively, of lagoon and reef islets it is not possible to say.

Kuda Bados, as other lagoon islets passed in reaching it, was made up of sand surrounded by narrow sandy beaches. The beach sand was white and fine. Small pieces of pumice were not uncommon. On the south side of this islet the beach was apparently being eroded, as the mat of coconut roots

was exposed for some distance and the small lagoon wavelets caused a swash to go up under the mat for an appreciable distance, though the surface layer of sand on top of the mat was disturbed for only the outer few decimeters. Shallow water with a sand bottom extended out 25 m or so, suggesting possibly this much erosion. The coconut trees are apparently unaffected by this process until they fall over. Evidences of similar erosion were noticed on parts of the shores of various islets where the beach is unprotected by a fringe of bushes.

Around the north part of the islet the sand forms a very low beach ridge, only 3 - 4 dm above high tide level and cut into by waves at that level. This ridge is covered by scrubby wood forming a narrow band. It is composed largely of Hibiscus tiliaceus, with some Hernandia, Guettarda, Pemphis, Calophyllum, Scaevola, and Messerschmidia, and with a little Pandanus, Suriana and Terminalia. This wood is dense but can be walked through at various places. This marginal band is scarcely developed on the south side of the islet.

The general level of the islet surface, except for the beach ridge, was very little above high tide level. The soil in a relatively open strip just inside the beach ridge was dark brown when moist, and almost black in the coconut grove. These soils did not change in the first 3-4 dm down. Earthworm casts were very abundant on the surface. Small fragments of brown consolidated material closely resembling the phosphate rock from Pacific Atolls were common in the soils, and larger fragments, up to cobble size, were scattered freely over the surface. Nothing like a continuous layer of this material was seen, nor were any Pisonia grandis trees found, such as would have been expected on a Pacific atoll with such phosphate rock. It is likely that a thousand years of close human occupation would have eliminated "useless" and easily destroyed trees like Pisonia, along with the birds that supplied the guano for the phosphate.

Under the coconut trees a few plants survived. Hibiscus, Calophyllum and a large Pandanus with edible fruit were scattered commonly in the groves, with some Morinda citrifolia and a few small Ochrosia saplings. Tacca and Crinum were common herbs, generally, with young plants of Flagellaria, tall spindly Abutilon, and occasional prostrate plants of Sida. In openings Dolichos formed mats. On open sand Nostoc colonies were locally abundant. Near the one house there was a patch of Turnera, a few small chlorotic breadfruit trees, a single tree each of Morinda and Tamarindus.

Chickens were common on this islet, scratching up the surface soil, possibly looking for earthworms. No other birds were seen except a small sandpiper.

The general aspect of this islet is fairly luxuriant, though the undergrowth is extremely sparse. Possibly the burning of piles of coconut trash, of which there is abundant evidence, may have something to do with this scarcity of undergrowth.

Furannafuri Islet on the east reef has an entirely different character than Kuda Bados. From a distance it appeared drier, the coconut trees were more sparse, and the brushy forest surrounding them more abundant. The islet was visited in the hope that it might show remnants of the original higher reef platform of the atoll, if there really had been such a platform. No such remnants, nor any consolidated rock, whatever, were found on the islet itself, though a few meters out from shore on the reef flat some extremely eroded snags of rock protrude above high-tide level. The nature of these was not investigated because of lack of time and because they could not be readily seen as the tide was high. The entire reef in this area was well covered by water.

The islet, elongated transversally to the reef, is a few hundred meters long and a hundred to two hundred meters wide. The lagoonward end, both the soil and the beach, is sandy and seems nowhere to reach more than about one meter above high tide level. As the outer end is approached the soil and beaches become more and more pebbly, until the outer hundred meters or more of the islet are a loose pebble flat surrounded by a sharp beach ridge a meter or more high of loose coral fragments from pebble to cobble size, very sharp and unworn. The soil, generally, on this islet, is a gray-brown more poorly developed type than on Kuda Bados, and nowhere was any phosphatic cemented rock seen.

Near the center but toward the lagoonward end is a well lined with concrete. Here, at the time of examination, the water level was about one meter or less below the general ground surface. The water was perceptibly brackish but would have been drinkable. This was near the end of the dry season of the year.

The general aspect of the vegetation is more luxuriant toward the inner end of the islet, possibly because of the sandy rather than pebbly nature of the soil. Here, besides a sparse stand of coconuts, the trees are mainly Hibiscus tiliaceus, Calophyllum inophyllum, and Terminalia catappa, with some Ficus, Hernandia and small Messerschmidia. A shrub layer, rather scattered but denser at the top of the beach, is mainly Scaevola sericea with some Guettarda speciosa and Pemphis acidula. This shrub layer is especially developed on the north side of the islet, and is very sparse at the south. In open and sparse places, especially near the center and to seaward, Wedelia biflora is common. The herbaceous layer is very sparse to almost absent, with locally some Fimbristylis cymosa and very locally, very stunted and dwarfed plants of Boerhavia.

Around the single house on the islet were a tree or two of Moringa oleifera, a scrubby lime, and a single small tree of the long-leafed edible species of Pandanus. All other Pandanus seen, the few trees around the beach on the inner end of the islet and thickets on the outer, were of the small-fruited very spiny inedible species.

Coconuts become more sparse on the outer part of the islet and are absent from the pebble flats on the extreme end. The outer end is largely occupied by an uneven thicket of Pemphis acidula, Cordia subcordata, and Pandanus, interspersed with pebble-lined pools containing a species of mangrove, Bruguiera. In one place, just back of the beach ridge, such a mangrove depression has been filled with pebble gravel, probably by storm waves, covering the bases of the mangrove trunks. The larger trees here are dead, the medium ones very sick-looking, and the small ones apparently quite healthy.

In the thickets there is no shrub or herb layer, no true undergrowth of any kind. However, its place is filled by stiff dead branches of Pemphis, low tangled limbs of Cordia and stilt roots of Pandanus, that make walking next to impossible except in openings between patches and clumps of thicket. The thicket changes from the north side to the south, and becomes locally dominated by Cordia, then by a mixture of Cordia and Pemphis, then by pure Pemphis, which extends well along the south shore toward the lagoon. Near the south shore are giant old "pollarded" Pemphis stumps, bushy with sprouts and up to almost a meter in diameter, that have obviously been cut back many times. Locally are Cordia of exactly the same habit, with even larger trunks.

Two crows were seen on this islet, and on the inner beach a flock of what seemed to be white terns, but these were not seen closely enough for identification.

Farucolofuri Islet was only examined from a distance from the lagoon side. Its central half is occupied by a dense coconut grove, thinning and becoming lower toward the ends, so that the fourth of it on each end is noticeably sparse, and by a pronounced scrub or scrub forest lining the shore and covering the ends of the islet; this is probably mostly of Pemphis. It is especially dense on the southwest corner where it seems a bit "wind-sheared", possibly from spray driven by the southwest monsoon. There is a sandy beach the entire length of the islet on the lagoon side, but in the center the beach is apparently subject to erosion, and a mat of coconut roots is exposed.

General features of what was seen of the atoll were the presence of broad bands of reef in the lagoon, covered by sand and irregular small growth of coral; extremely low altitude and little relief of the islets; lack of emerged reef conglomerate or of any development of beach rock; prevalence of islets within the lagoon; common occurrence of active beach erosion by lagoon waves; scarcity of birds; and general intensive human influence on and control of all features of the land surface.

On the basis of this brief visit, it is not possible to make any generalization whatever as to the atolls of the Maldivé group. It is worth noting, however, that in many respects the observer gains an impression of dissimilarity with the Pacific atolls, of perhaps greater

complexity in geologic structure, and of a strong difference in human ecology, economy, and culture. These impressions strongly suggest that a longer investigation of this group of atolls would be desirable before much in the way of generalization on atoll geology and atoll ecology is attempted. It is clear that such an investigation by qualified scientists would be of benefit to the people of the Maldives, would be welcomed by their government, and that excellent cooperation could be expected.

Systematic list of plants of the Maldivé Islands

In 1901 Willis and Gardiner compiled a list of 284 species of plants known to occur in the Maldivé Islands, including about a dozen very dubious reports of plants not determined to species. The list is largely based on plants collected by Mr. Gardiner during his zoological and oceanographic investigations but includes also all species previously reported in the literature or sent in by other collectors. In addition to the systematic list the authors include a detailed description of the vegetation, considerations of economic plants of various sorts, a list of vernacular names, and a discussion of the origin of the flora.

With only two days at my disposal and many other observations to make, my collecting was of necessity very hasty and superficial compared with the thorough work of Gardiner. Nevertheless, my collection includes 29 species not mentioned in the Willis and Gardiner list. They are mostly weeds and cultivated plants. In the course of working up the collection the nomenclature used by Willis and Gardiner was largely revised. Therefore, it seems desirable to present a complete enumeration of the plants known from the archipelago, giving references to Willis and Gardiner, the native names recorded by them and those given me by Mr. Lajeki Ebrahim Didi, of Malé, for the plants I collected. For plants not recorded by Willis and Gardiner notes on occurrence and use are included. In addition to plants actually collected, 15 species cultivated in gardens in Malé and unreported by Willis and Gardiner are listed as seen but not collected; these reports can, except where otherwise noted, be regarded as fairly reliable, as these species are familiar ones.

Gardiner's collections were not available for examination, and the identification of a few plants seems open to doubt; for those a note has been made of what is probably the modern name of the plant, if it is different from that used by Willis and Gardiner. The doubtful records, not determined to species by them, have been excluded from the present list.

The total vascular flora, thus recorded here, is 323 species, to which are added two mosses and one Nostoc. Mr. W. W. A. Phillips has recently made a collection which I have not seen. Other species may be added when his list becomes available. A full set of my specimens will be deposited in the U. S. National Herbarium. The abbreviation W & G refers to the record for a species in Willis and Gardiner's list. Only the atolls from which the plant is recorded and the native names have been extracted. For further information the original paper can be consulted.

Note:

After this paper had been prepared, a letter was received from Mr. A. S. A. Packeer, Assistant Warden, Department of Wild Life in Colombo, reporting on the plants collected by Mr. Phillips. They are:

1. *Lumnitzera coccinea* (see *L. littorea* in systematic list)
2. *Tournefortia argentea* (see *Messerschmidia argentea*)
3. *Scaevola frutescens* (see *S. sericea*)
4. *Calotropis gigantea*
5. *Pemphis acidula*
6. *Averrhoa bilimbi*
7. *Indigofera tinctoria*
8. *Rhoeo discolor*
9. *Wedelia biflora*
10. *Nephrolepis exaltata*
11. *Premna serratifolia* (see *P. obtusifolia*)
12. *Cyperus conglomeratus*

We acknowledge with thanks the opportunity to add these records to this report.

ALGAE

Nostocaceae

Nostoc sp.

Malé Atoll, Malé Islet, common locally on bare sand, Fosberg 36829.

BRYOPHYTA

Calymperaceae

Calymperes hyophilaceum C. Müller

Malé, Kuda Bados I., on base of coconut tree, Fosberg 36899b,
det. H. A. Miller.

PTERIDOPHYTA

Psilotaceae

Psilotum nudum (L.) Griseb.

Goifurfehendu; Haddumati; Suvadiva. W & G p. 112 as Psilotum
triquetrum Sw. "Prumo."

Polypodiaceae

Asplenium nidus L.

Kolumadulu; Haddumati; Suvadiva. W & G p. 112 as Thamnopteris nidus L.

Nephrolepis exaltata (L.) Schott

Malé; S. Mahlos; Kolumadulu; Haddumati; Suvadiva. W. & G p. 112. "Kees
fila", "Makunu hungal."

Probably not this species.

Thelypteris dentata (Forsk.) C. P. St John

Haddumati. W & G p. 112 as Nephrodium molle Desv.

GYMNOSPERMAE

Cycadaceae

Cycas circinalis L.

Malé, island near Malé I. W & G p. 111.

ANGIOSPERMAE

Pandanaceae

Pandanus hornei Balf. f. ?

Malé, Kuda Bados I., Fosberg 36899; Malé I. (in market), Fosberg 36899a, "karikio."

A large tree with spines close together and appressed, fruit heads large, fruit eaten.

Malé; S. Mahlos; Goifurfehendu; N. Mahlos; Addu, etc. W & G p. 104.

"Karikeo", "Keeva" (in Addu Atoll).

Pandanus odoratissimus L.f.?

Malé, Malé I., forming thicket, Fosberg 36916. "Bokio."

A rather small species with the leaves somewhat persistent, the spines fairly remote and diverging strongly, the heads small and the fruits inedible.

S. Mahlos; Addu, etc. W & G p. 104. "Bokeo", "Divihe keeva" (in Addu).

Gramineae

Apluda varia var. aristata L.

Goifurfehendu; Male; Kolumadulu; common in the whole group. W & G p. 109. "Ona hui."

Bambusa arundinacea Willd.

Malé and other islands. W & G p. 111.

[Bambusa multiplex (Lour.) Rauschel?]

Maldives. W & G p. 111.

Bambusa vulgaris Schrad.

Miladumadulu. W & G p. 111.

Brachiaria subquadripara (Trin.) Hitchc.

Malé, Malé I., occasional in dense weedy sod, Fosberg 36864. "Ono vina".

Cymbopogon nardus (L.) Rendle

Male. W & G p. 110 as Andropogon nardus L. "Kasinji."

Digitaria sanguinalis (L.) Scop.

Goifurfehendu; Suvadiva. W & G p. 107 as Paspalum sanguinale (L.) Lam.

Tropical specimens referred to this species are more often actually D. ciliaris (Retz) Koel.

Eleusine aegyptiaca (L.) Desf.

Goifurfehendu; Miladumadulu. W & G p. 110.

Eleusine coracana (L.) Gaertn.

Grown here and there in the archipelago. W & G p. 110. "Bimbi", "Beembi."

Eleusine indica (L.) Gaertn.

Male, Malé I., common, Fosberg 36863. "Vina" = small grass.

Eragrostis amabilis (L.) W. & A.

Malé, Malé I., Fosberg 36860. "Tumbuli vina."

Malé; Goifurfehendu. W & G p. 111 as Eragrostis tenella var. plumosa Stapf. "Tubuli hui", "Sannipoo."

Ischaemum ciliare Retz.

Malé. W & G p. 109. "Bileh-hui."

Ischaemum muticum L.

S. Mahlos; Goifurfehendu. W & G p. 109.

Oplismenus compositus (L.) Beauv.

S. Mahlos; Malé; Kolumadulu; Suvadiva; Addu. W & G p. 107. "Ona hui."

Oryza sativa L.

Occasionally cultivated in some islands, but will not grow and set seed. W & G p. 108. "Handu."

Panicum miliaceum L.

N. Mahlos; Miladumadulu. W & G p. 107. "Bai."

Paspalum vaginatum Sw.

Male, Malé I., local back of lagoon shore, Fosberg 36853.

Pseudoraphis squarrosa (L.f.) Chase

Male; N. Mahlos; Suvadiva. W & G p. 110 as Andropogon squarrosus L.f. "Lancimo", "Lunsimoo."

Saccharum officinarum L.

Malé, Malé I., seen but not collected, Fosberg in 1956.

"Nearly all the larger islands of the group..." W & G p. 109. "Udandi."

Setaria italica (L.) Beauv.

N. Mahlos. W & G p. 108. "Ura."

Sorghum bicolor (L.) Moench

"Formerly cultivated in the Maldives." W & G p. 110 as Andropogon sorghum Brot. "Zoowari."

Spinifex squarrosus L.

N. Mahlos; Goifurfehendu, etc. W & G p. 107.

Stenotaphrum complanatum Schrank

Kolumadulu. W & G p. 108.

Thuarea involuta (Forst.f.) R. & S.

Malé, Malé I., Fosberg 36822.

S. Mahlos; Goifurfehendu; common throughout archipelago. W & G p. 108. as Thuarea sarmentosa Pers.

Zea mays L.

Malé; Miladumadulu. W & G p. 109. "Donera", "Donala."

Zoysia pungens Willd.

Malé. W & G p. 108.

Cyperaceae

Cladium jamaicense Crantz

Addu. W & G p. 107.

Cyperus bulbosus Vahl

Malé, Malé I., common in grassy area on top of old fort, Fosberg 36912, "gok kulanduru."

Roots and tubers fragrant, sometimes used as incense.

Cyperus conglomeratus Rottb.

Malé, Kuda Bados I., on beach, Fosberg 36886.

Nut broadly elliptical, light chestnut brown.

Cyperus dubius Rottb.

Malé. W & G p. 106 as Mariscus dregeanus Kunth. "Hui ru", "Kalandura gundi."

Cyperus hyalinus Vahl

Goifurfehendu. W & G p. 105, as Pycneus pumilus Nees.

Cyperus javanicus Houtt.

Goifurfehendu. W & G p. 106 as Mariscus albescens Gaud. ?

Cyperus polystachyos Rottb.

Suvadiva; Addu. W & G p. 105 as Pycneus polystachyus Beauv. "Kuna."

Cyperus rotundus L.

Malé Malé I., on low waste ground near lagoon, Fosberg 36840. "dandukari!"

Fimbristylis cymosa R. Br. var.

Malé, Malé I., common in open bare places, Fosberg 36848.

Malé; Goifurfehendu; Kolumadulu. W & G p. 106 as Fimbristylis spathacea Roth.

Araceae

Acorus calamus L.

Malé. W & G p. 105 "Huvago."

Alocasia indica (Roxb.) Schott

Malé. W & G p. 105. "Ma ala."

Colocasia esculenta (L.) Schott

Tiladumati; Addu; sparsely throughout archipelago. W & G p. 104 as Colocasia antiquorum Schott. "Ala."

[Cyrtosperma sp. ?]

In some islands. W & G p. 104 as "identical with...Cyrtosperma edule Schott."

Raphidophora pertusa Schott

Haddumati. W & G p. 105.

Lemnaceae

Lemna oligorrhiza Kurz ?

Malé, Malé I., covering surface of water in well, Fosberg 36906.

Palmae

Areca cathecu L.

Malé, Malé I., cultivated, seen but not collected, Fosberg in 1956.
Miladumadulu; Malé; Suvadiva; Addu. W & G p. 102. "Femfora"; "Fo"
or "Fakou" (nut).

Cocos nucifera L.

Malé, Malé I., Kuda Bados I., Furannafuri I., seen but not collected,
Fosberg in 1956.
"Practically all the islands other than mere sandbanks." W & G p. 103.
"Khari", "Kairi". (Addu), "Bo."

Phoenix dactylifera L.

Malé, Malé I., cultivated, seen but not collected, Fosberg in 1956.

Flagellariaceae

Flagellaria indica L.

Malé, Kuda Bados I., common in coconut plantation, only sterile
plants seen, Fosberg 36896. "Vihalla gondi."

Bromeliaceae

Ananas comosus (L.) Merr.

Ari. W & G p. 99 as Ananas sativus L. "Anana."

Commelinaceae

Commelina benghalensis L.

Malé. W & G p. 102. "Diyamudoli."

Commelina kurzii Clarke

S. Mahlos; Malé; Haddumati; Suvadiva; Addu. W & G p. 102. "Tilo lagundi."

Cyanotis cristata Schultes f.

Haddumati. W & G p. 102.

Rhoeo discolor Hance

Malé; Addu. W & G p. 102 as Rhaeo discolor. "Re kandolu."

Liliaceae

Asparagus racemosus Willd.

Malé. W & G p. 101. "Satavaru."

Cordyline terminalis (L.) Kunth

Malé, Malé I., cultivated, seen but not collected, Fosberg in 1956.

Gloriosa superba L.

Malé; S. Mahlos; Goifurfehendu; northern half of Archipelago. W & G p. 101. "Wihelia-gundi."

Amaryllidaceae

Crinum asiaticum L.

Goifurfehendu; everywhere in archipelago. W & G p. 99.

Hippeastrum puniceum (Lam.) Urb. ?

Malé, Malé I., cultivated, seen but not collected, Fosberg in 1956.

Hymenocallis littoralis (Jacq.) Salisb.

Malé, Malé I., cultivated, seen but not collected, Fosberg in 1956.

This is possibly the plant reported by W & G as Pancratium sp.

Pancratium zeylanicum L.

Suvadiva. W & G p. 100.

Dioscoreaceae

Dioscorea alata L.

Malé; all over the group. W & G p. 101. "Billi-kattala."

Dioscorea fasciculata Roxb.

Malé. W & G p. 101. "Kurukuru."

Dioscorea globosa Roxb.?

Malé. W & G p. 101. "Mativa", Mathe-wa."

Dioscorea pen'aphylla L.

Malé; Tiladumati; Addu. W & G p. 101. "Kattela."

Dioscorea purpurea Roxb.?

Malé. W & G p. 101. "Bilek-kattala."

Dioscorea rubella Roxb.?

Malé. W & G p. 101. "Kattala."

Taccaceae

Tacca leontopetaloides (L.) O. Kuntze

Malé, Kuda Bados I., Fosberg 36883. "hit tala."

Malé; Goifurfehendu; "common in the whole archipelago." W & G p. 100
as Tacca pinnatifida Forst. "Hitala", "Hittala", Heith-thala."

Musaceae

Musa sapientum L.

Malé, Malé I., cultivated, seen but not collected, Fosberg in 1956.
Tiladumati; N. Mahlos; Suvadiva; most islands. W & G p. 99. "keo",
"dongkeo."

Casuarinaceae

Casuarina equisetifolia L.

Malé, Malé I., cultivated, trimmed into hedges, seen but not collected, Fosberg in 1956.

Piperaceae

Piper betle L.

Malé, Malé I., cultivated, seen but not collected, Fosberg in 1956.

Malé; Miladumadulu; Addu; all atolls. W & G p. 93. "Billi"; "Wang" and "Billaton" (Addu) are names for leaf.

Piper nigrum L.

Malé. W & G p. 93.

Moraceae

Artocarpus altilis (Park.) Fosb.

Malé, Malé I., cultivated, seen but not collected, Fosberg in 1956.

Malé; S. Mahlos; N. Mahlos; Goifurfehendu; "nearly every inhabited island of the group." W & G p. 98 as Artocarpus incisa L.f.

"Bambukea", "Banke"(Addu).

Artocarpus heterophylla Lam.

Malé. W & G p. 98 as Artocarpus integrifolia L.f. "Sakkeyo."

Ficus benghalensis L. ?

Malé; N. Mahlos. W & G p. 97. "Nika."

Ficus infectoria Roxb.

Malé, Malé I., occasional, banyan-like but multiple trunk and aerial roots not much developed, Fosberg 36845 ? "Dumbu."

Malé. W & G p. 98. "Dumbu."

Ficus mysorensis Heyne?

Malé, Malé I., one tree seen on playground near outer beach, Fosberg 36821. "Fili."

Possibly the same as the Ficus sp. with this vernacular name reported by W & G p. 97.

Ficus religiosa L.

Malé; Fua Mulaku; Suvadiva. W & G p. 98. "Boi."

Ficus retusa L. ?

Malé. W & G p. 98. "Kudehi."

Urticaceae

Fleurya interrupta Gaud.

Malé; Kolumadulu; W & G p. 98. "Gakehebuli."

Pilea microphylla L.

Malé, Malé I., in crevices in walls along streets, Fosberg 36914.

Pouzolzia indica Gaud.

Malé; Goifurfehendu; Kolumadulu. W & G p. 99. "Giteyokoli", "Gitakoli."

Polygonaceae

Antigonum leptopus H. & A.

Malé, Malé I., cultivated, seen but not collected, Fosberg in 1956.

Malé. W & G p. 93.

Nyctaginaceae

Boerhavia diffusa L.

Male; Goifurfehendu; Kolumadulu; common throughout archipelago.

W & G p. 90. "Burandagondi", "Nanubedi."

Boerhavia erecta L.

Malé, Malé I., weedy sod back of beach, Fosberg 36859.

Boerhavia repens L.?

Malé, Malé I., rare in dense weedy sod back of beach, Fosberg 36869, 36870. "Burunda gondi."

No. 36869 abnormal, possibly infected by Albugo.

Malé, Furannafuri I., common along trails in sparse coconut plantation, Fosberg 36901. "Burunda gondi." Root eaten.

Bougainvillea spectabilis Willd.

Malé, Malé I., cultivated, seen but not collected, Fosberg in 1956.

Malé. W & G p. 91.

Mirabilis jalapa L.

Malé, Malé I., cultivated, seen but not collected, Fosberg in 1956.

Malé. W & G p. 91. "Asuraffole re"(red), "Asuraffole hudu" (white), "Re asaruman", "Asarumu."

Pisonia aculeata L.?

Kolumadulu. W & G p. 91.

Pisonia grandis R. Br.

Malé, Malé I., doubtfully seen, cultivated, but not collected, Fosberg in 1956.

Malé; Kolumadulu. W & G p. 91 as Pisonia morindaefolia Br. "Los."

Amaranthaceae

Achyranthes aspera L.

Malé; S. Mahlos. W & G p. 92. "Karhi léibú."

Aerua lanata L.

Malé; S. Mahlos; Goifurfehendu; Kolumadulu; everywhere except in Addu.

W & G p. 92. "Hudufupila."

Amaranthus caudatus L.

Malé. W & G p. 92. "Raidadisagu."

Amaranthus spinosus L.

Malé. W & G p. 92.

Amaranthus tricolor L.

Malé. W & G p. 92 as Amaranthus gangeticus L.

Amaranthus viridis L.

Malé, Malé I., Fosberg 36844. "Masagu," eaten as potherb.

Malé. W & G p. 92. "Massagu."

Celosia argentea L.

Haddumati. W & G p. 92.

Nothosaerua brachiata Wight

Malé, Malé I., Fosberg 36868. "huduhup pila."

Malé. W & G p. 92.

Aizoaceae

Sesuvium portulacastrum L.

Malé. W & G p. 74. "Mapijja."

Portulacaceae

Portulaca oleracea L.

Malé, Malé I., common in open places, Fosberg 36847.

"Raid geda" eaten as potherb.

Malé. W & G p. 53. "Rai-geda."

Portulaca quadrifida L.

Malé, Malé I., local, Fosberg 36831.

Malé. W & G p. 54. "Makuna-fila"

Portulaca tuberosa (Roxb.) Trim.

Malé; Goifurfehendu; Kolamadulu. W & G p. 54. "Riindu-filia."

Annonaceae

Annona muricata L.

Malé; fairly common throughout northern atolls; Suvadiva; Addu. W & G p. 52. "Anona", "Ata."

Annona squamosa L.

Malé; Addu. W & G p. 52. "Ata."

Artabotrys odoratissimus R. Br.

Malé. W & G p. 51. "Chunpápool."

Menispermaceae

Tinospora cordifolia Miers

Malé. W & G p. 52.

Lauraceae

Cassytha filiformis L.

Male, Kuda Bados I., climbing over trees, not abundant, Fosberg 36893.
"Vela buli."

Male; Goifurfehendu; Kolumadulu. W & G p. 93. "Dom velam buli,"
"Vele buli."

Hernandiaceae

Gyrocarpus jacquini Roxb.

S. Mahlos; through the whole group. W & G p. 69.

Hernandia sonora L.

Male, Kuda Bados I., common in scrub forest on beach ridge, Fosberg
36889. "Kandu."

Malé; Goifurfehendu; S. Mahlos; Kolumadulu; common in whole group.

W & G p. 94 as Hernandia peltata Meissn. "Kando", "Maskando", "Kadu."

Papaveraceae

Argemone mexicana L.

Male; Addu. W & G p. 52. "Zaggumu."

Capparidaceae

Cleome viscosa L.

Goifurfehendu; Miladumadulu; Malé. W & G p. 53. "Rábeburi."

Gynandropsis gynandra (L.) Briq.

Goifurfehendu; Kolumadulu. W & G p. 53 as Gynandropsis pentaphylla DC.

Cruciferae

Brassica juncea Hook.f. & Th.

Malé. W & G p. 52. "Revi."

Moringaceae

Moringa oleifera Lam.

Male, Kuda Bados I., one tree in coconut plantation, Fosberg 36885.

"Morunga" leaves and fruit eaten as potherb.

Male; Kolumadulu; common in all the group. W & G p. 62 as Moringa pterygosperma Gaertn. "Muranga."

Crassulaceae

Kalanchoe pinnata (Lam.) Pers.

Malé, Malé I., occasional, Fosberg 36823. "Fatungas fala."

Malé; very sparsely through the group. W & G p. 68 as Bryophyllum calycinum Salisb. "Bodu faru," "Fatunfaifila."

Rosaceae

Rosa sp.

Malé; Miladumadulu. W & G p. 68. "Fini-fenma."

Leguminosae

Acacia farnesiana (L.) Willd.

Malé; Goifurfehendu; Kolumadulu; common in south of group, rare in north. W & G p. 67. "Bés-góbili."

Adenanthera pavonina L.

Malé. W & G p. 67.

Albizia lebbek L.

Malé, Malé I., one tree seen in open flat at end of island, Fosberg 36838. "Riitikas."

Alysicarpus vaginalis (L.) DC.

Malé, Malé I., common in dense weedy sod back of beach, Fosberg 36866.

Caesalpinia bonduc (L.) Roxb.

Goifurfehendu; Kolumadulu; Malé; common in whole archipelago. W & G p. 65 as Caesalpinia bonducella Fleming. "Karikuburu."

Caesalpinia major (Medic.) Dandy & Exell ?

Maldives. W & G p. 65 as Caesalpinia bonduc?

Caesalpinia pulcherrima (L.) Sw.

Malé. W & G p. 66. "Fatangu."

Canavalia ensiformis DC.

Kolumadulu. W & G p. 64. "Talafuri."

Canavalia lineata DC.

Malé; S. Mahlos. W & G p. 64. "Manifa."

Cassia auriculata L.

Malé. W & G p. 66. "Ranawia."

Cassia occidentalis L.

Malé; Miladumadulu. W & G p. 66. "Kuhada."

Cassia sophora L.

Goifurfehendu; Malé; Kolumadulu; Addu; Suvadiva. W & G p. 66. "Rana-rua."

Cassia surattensis Burm. f.

Malé, Kuda Bados I., rare in semi-open place, Fosberg 36895. "Rana ura."

Malé. W & G p. 66 as Cassia glauca var. suffruticosa Koenig. "Rana-ura."

Cassia tora L.

Goifurfehendu. W & G p. 66.

Clitoria ternatea L.

Goifurfehendu. W & G p. 65.

Crotalaria retusa L.

Malé, Malé I., rare in coconut plantation, Fosberg 36898. "Viha giguna."

Malé; Haddumati. W & G p. 62. "Viha-giguni."

Delonix regia (Boj.) Raf.

Malé, Malé I., cultivated, seen but not collected, Fosberg in 1956.

Malé. W & G p. 66 as Poinciana regia Boj. "Kandi-toli."

Desmodium gangeticum (L.) DC.

S. Mahlos. W & G p. 63.

Desmodium triflorum (L.) DC.

Kolumadulu. W & G p. 63. "Hekoopie."

Desmodium umbellatum (L.) DC.

Goifurfehendu; very common in archipelago. W & G p. 63.

Dolichos lablab L.

Malé, Kuda Bados I., climbing in bushes and trees and creeping on ground in open or partially open places, Fosberg 36894.

"Du himeri", bean eaten by some people.

Malé; Haddumati. W & G p. 65. "Himerri."

Entada scandens Benth.

Malé. W & G p. 67.

Probably is E. pursaetha DC. (vide Brennan, Kew Bull. 1955: 161-170) but since only the seeds are known and these were found on the beach the species can scarcely be determined and the plant is probably not a member of the Maldivé flora.

Erythrina indica L.

Malé. W & G p. 64. "Berebedi."

Indigofera enneaphylla L.?

Malé, Malé I., common in grassy area on top of old fort, Fosberg 36911.

Indigofera tinctoria L.

Malé, Malé I., occasional, Fosberg 36828, 36862. "Fang hiti."

Malé; S. Mahlos; Goifurfehendu; Kolumadulu. W & G p. 62. "Vihafilia."

Mimosa pudica L.

Malé. W & G p. 67. "Ladu."

Pachyrhizus erosus (L.) Urb.

Malé. W & G p. 65 as Pachyrhizus angulatus Rich. "Viha-toli."

Peltophorum pterocarpum (DC.) Backer ex K. Heyne

Malé, Malé I., cultivated, seen but not collected, Fosberg in 1956.

Phaseolus lunatus L.

Malé. W & G p. 64. "Himeri."

Samanea saman (Jacq.) Merr.

Malé, Malé I., cultivated, seen but not collected, Fosberg in 1956.

Sophora tomentosa L.

Malé; Goifurfehendu. W & G p. 65.

Tamarindus indica L.

Malé; Goifurfehendu; Addu; "sparsely near villages everywhere." W & G p. 67. "Helebeli."

Tephrosia purpurea var. pumila Baker

S. Mahlos. W & G p. 63.

Tephrosia tenuis Wall

Malé. W & G p. 63. "Fesko."

Vigna marina (Burm.) Merr.

Kolumadulu. W & G p. 64 as Vigna lutea A. Gray.

Oxalidaceae

Averrhoa bilimbi L.

Malé, Malé I., commonly planted around houses, Fosberg 36907.

Malé. W & G p. 58. "Bilimagu."

Averrhoa carambola L.

Malé. W & G p. 58. "Kamaraga."

Zygophyllaceae

Tribulus terrestris L.

Malé. W & G p. 58.

Rutaceae

Citrus aurantifolia (Christm.) Swingle

Malé, Furannafuri I., seen but not collected, Fosberg in 1956.

Maldives; "generally cultivated." W & G p. 59 as Citrus medica var. acida Brandis. "Limbo."

Citrus aurantium L.

Fua Mulaku. W & G p. 59. "Moli."

Citrus decumana L.

Malé; Addu. W & G p. 59. "Niyaduru."

Citrus limon Burm.f.

Miladumadulu. W & G p. 59 as Citrus medica var. Limonum. "Bodu Limbo" (big lime).

Murraya koenigii Spreng.

Malé. W & G p. 58. "Hikundi."

Triphasia trifoliata DC.

Malé, Malé I., cultivated, seen but not collected, Fosberg in 1956.

Malé; "very scarce in the N., and not in the S., of Archipelago." W & G p. 58. "Kudalimbo" (small lime).

Simarubaceae

Suriana maritima L.

Malé, Malé I., occasional at top of beach, Fosberg 36890. "halaveli."

Malé; Goifurfehendu. W & G p. 59. "Hala veli", "Halia veli."

Meliaceae

Azadirachta indica Juss.

Malé, Malé I., planted, Fosberg 36908. "Hiti."

Malé. W & G p. 59. "Hiti."

Polygalaceae

Polygala erioptera DC.

Goifurfehendu; S. Mahlos; "fairly common everywhere in the north."

W & G p. 53.

Euphorbiaceae

Acalypha amentacea vars.

Malé, Malé I., cultivated, Fosberg 36880.

This is the plant with red leaves commonly called A. wilkesiana M.-A.

The form called A. wilkesiana var. circinata was seen also, but not collected.

Acalypha indica L.

Malé; Goifurfehendu; Addu. W & G p. 96. "Vaffufuli."

Acalypha lanceolata Willd.

Malé, Malé I., locally common in dense weedy sod back of beach, Fosberg 36871.

Malé; Goifurfehendu; Kolumadulu; Suvadiva; Addu. W & G p. 97 as

Acalypha fallax M.-A. "Bissagu", "Cave."

Acalypha paniculata Miq.

Malé. W & G p. 96. "Dagundi kandi", "Meia-ságu."

Agyneia bacciformis A. Juss.

Addu. W & G p. 95.

Aleurites moluccana (L.) Willd.

Malé, Malé I., cultivated, seen but not collected, Fosberg in 1956.

Codiaeum variegatum (L.) Bl.

Malé, Malé I., cultivated, Fosberg 36879. "Domphai baguitsa."

Croton tiglium L.

Kolumadulu. W & G p. 96.

Euphorbia atoto Forst.

Goifurfehendu; Male; frequent in group. W & G p. 94. "Kiru tina."

Very probably not this species, possibly E. chamiissonis Boiss.

Euphorbia clarkeana Hook. f.

Male, Male I., occasional to common locally in waste places, Fosberg 36830.

This may be what W & G report as E. thymifolia L. from Kolumadulu Atoll.

Euphorbia heterophylla L.

Male, Male I., very common in waste places, Fosberg 36850.

Euphorbia hirta L.

Male, Male I., common, Fosberg 36867. "Kirutina."

Male; S. Mahlos. W & G p. 95 as Euphorbia pilulifera L. "Kirutina."

Euphorbia hypericifolia var. parviflora L.

S. Mahlos; Kolumadulu; Addu. W & G p. 94. "Kerutina."

Euphorbia thymifolia L.

Kolumadulu. W & G p. 95.

Glochidion littorale Forst.?

Male. W & G p. 96. "Emboo."

Manihot esculenta Crantz

Male, Male I., cultivated, seen but not collected, Fosberg in 1956.

Male. W & G p. 96 as Manihot utilissima Pohl.

Micrococca mercurialis (L.) Benth.

Male, Male I., rare, Fosberg 36872.

Pedilanthus tithymaloides Poit.

Male; Addu. W & G p. 94. "Kala kiru."

Phyllanthus amarus Schum. & Thonn.

Male, Male I., occasional in weedy sod back of beach, Fosberg 36861.

Male; Goifurfehendu; Kolumadulu. W & G p. 96 as Phyllanthus niruri L.

Phyllanthus debilis Klein ex Willd.

Male, Male I., common in weedy places, Fosberg 36856.

"Kaalumumbo."

Phyllanthus distichus M.-A.

Male. W & G p. 96. "Gobili."

Phyllanthus maderaspatensis L.

Male, Male I., common, Fosberg 36873. "Kudihiti."

Male; S. Mahlos; Goifurfehendu; Kolumadulu. W & G p. 95. "Meia limbo", "Kudingke."

Phyllanthus nivosus Bull

Malé, Malé I., cultivated, Fosberg 36877.

This should probably be placed in a separate genus, usually called Breynia Forst., but this generic name is a later homonym of Breynia L. and no name is available for the genus at present.

Phyllanthus urinaria L.

S. Mahlos; Goifurfehendu. W & G p. 95.

Ricinus communis L.

Malé, Malé I., common, Fosberg 36843. "Raing amanaka."

Malé; Goifurfehendu; Kolumadulu; "all over the islands." W & G p. 97.

"Amanaka."

Trewia nudiflora L.?

Malé. W & G p. 97. "Varukundu."

Anacardiaceae

Mangifera indica L.

Malé, Malé I., cultivated, seen but not collected, Fosberg in 1956.

Malé. W & G p. 62.

Sapindaceae

Allophylus cobbe Bl.

Male; S. Mahlos; Goifurfehendu; Kolumadulu. W & G p. 61. "Dom Moussa."

Cardiospermum helicacabum L.

Malé. W & G p. 61.

Dodonaea viscosa L.

Malé; Goifurfehendu; Kolumadulu. W & G p. 61. "Kudiruvali."

Rhamnaceae

Colubrina asiatica (L.) Brongn.

Malé; S. Mahlos; N. Mahlos. W & G p. 60. "Ra-rohi."

Zizyphus jujuba (L.) Lam.

Malé, Malé I., Fosberg 36875. "Kun'nar."

Malé; Goifurfehendu; Kolumadulu; common in whole group. W & G p. 60.

"Kunnáru", "Konara."

Vitaceae

Vitis linnaei Wall?

Malé. W & G p. 60.

Tiliaceae

Corchorus aestuans L.

Malé; Goifurfehendu; Kolumadulu. W & G p. 57 as Corchorus

acutangulus Lam. "Nanubeddi", "Hiridigga", "Kaduru", "Gethawcoley."

Corchorus capsularis L.

Malé. W & G p. 57. "Bulukiya."

Muntingia calabura L.

Male, Male I., spontaneous in crevice in old fort, Fosberg 36914.

"Jaam" fruit eaten.

Malvaceae

Abutilon indicum (L.) Sweet

Malé, Kuda Bados I., occasional in coconut plantation, Fosberg 36897.

"Ma-bula" leaves eaten in curry.

Malé; Goifurfehendu; very common everywhere. W & G p. 55. "Má-Bulá."

Gossypium barbadense var. acuminatus Roxb.

Malé; Goifurfehendu; Kolumadulu; "sparingly cultivated in whole group."

W & G p. 56. "Bodu kafa."

Gossypium herbaceum L.

Malé, Malé I., occasional, Fosberg 36841. "Ok kafa."

A shrub 2 m tall growing spontaneously, with some doubt referred to this species.

Malé; N. Mahlos. W & G p. 56. "Kafa."

Hibiscus abelmoschus L.?

Suvadiva; Kolumadulu. W & G p. 56.

Hibiscus rosa-sinensis L.

S. Nilandu. W & G p. 56.

Hibiscus solandra L'Her.

Malé, Kuda Bados I., rare in plantation, Fosberg 36884.

Malé; S. Mahlos; Goifurfehendu; Kolumadulu; "sparingly everywhere in group. W & G p. 55. "Nadu-kandi", "Kukulufaifila."

Hibiscus tiliaceus L.

Malé, Malé I., common on seaward flats, Fosberg 36832. "Dika."

Malé; S. Mahlos; Goifurfehendu; Kolumadulu; common throughout group. W & G p. 56. "Diga."

Hibiscus (ornamental hybrids)

Malé, Malé I., several cultivated ornamental hybrid Hibiscus seen, but not collected, Fosberg in 1956.

Sida carpinifolia L.

Malé; Haddumati. W & G p. 55. "Mirajjé sai."

Sida humilis Willd.

Malé, Malé I., Fosberg 36846, 36854. "Weodikka", "reodikka."

Malé; S. Mahlos; Addu. W & G p. 54. "Veyo-diggá."

Thespesia populnea (L.) Sol. ex Correa

Malé, Malé I., common generally, especially along lagoon shore, Fosberg 36852. "Hirundu." Wood used for freeboard of boats.

Malé; "all over-archipelago." W & G p. 56. "Hirundu."

Bombacaceae

Adansonia digitata L.

Male; W & G p. 57. "Foh."

Ceiba sp.

Male, Male I., a large buttressed tree probably belonging to this genus seen but not collected, Fosberg in 1956.

Sterculiaceae

Abroma augusta L.

Male. W & G p. 57. "Garada."

Guttiferae

Calophyllum inophyllum L.

Male, Kuda Bados I., common in and around coconut plantation, Fosberg 36887. "Funa."

Male; N. Mahlos; very common in S. of group. W & G p. 54. "Funa."

Turneraceae

Turnera ulmifolia var. elegans (Otto) Urb.

Male, Male I., common generally especially along lagoon shore, Fosberg 36849, also seen on other islets.

This is large-leaved, yellow-flowered form of this species.

Passifloraceae

Passiflora coerulea L.

Male. W & G p. 72.

Passiflora edulis Sims

Male, Male I., cultivated, seen but not collected, Fosberg in 1956.

Caricaceae

Carica papaya L.

Male, Male I., cultivated, seen but not collected, Fosberg in 1956.

Male; S. Mahlos; Goifurfehendu. W & G p. 72. "Falo."

Cucurbitaceae

Benincasa cerifera Savi.

Male. W & G p. 73. "Fufu."

Citrullus colocynthis Schrad.?

Male. W & G p. 73. "Kara."

Citrullus vulgaris Schrad.

"Commonly cultivated in the Archipelago." W & G p. 73.

Cucumis sativus L.

Malé; S. Mahlos; Kolumadulu; Miladumadulu. W & G p. 73. "Kekuri."

Cucurbita maxima Duch. ?

Malé; Addu. W & G p. 74.

Cucurbita moschata Duch.

Malé; Addu. W & G p. 74.

Cucurbita pepo L.

Malé. W & G p. 74. "Burubo."

Luffa aegyptiaca Mill.?

Malé. W & G p. 73. "Tora."

Momordica charantia L.

Malé. W & G p. 73. "Faga."

Trichosanthes cucumerina L.

N. Mahlos; Addu. W & G p. 73.

Lythraceae

Lagerstroemia indica L.

Malé, Malé I., cultivated, seen but not collected, Fosberg in 1956.

Lawsonia inermis L.

Malé, Malé I., planted in park, Fosberg 36915.

Leaves said to be crushed in milk to impart red color to women's hands.

Malé; Goifurfehendu. W & G p. 71 as Lawsonia alba Lam. "Heena", "Innapa."

Pemphis acidula Forst.

Malé, Kuda Bados I., abundant at top of beach, on sand, Fosberg 36891.

"Kuredi" wood used for keels of boats.

Malé; Goifurfehendu; Kolumadulu; S. Mahlos; "common in all the Maldives." W & G p. 71. "Dhadukuradi", "Kuredi", "Kuradu."

Sonneratiaceae

Sonneratia alba J. Sm.

Malé; Addu; Miladumadulu. W & G p. 71 as Sonneratia acida L. "Kulowa."

Punicaceae

Punica granatum L.

Malé, Malé I., cultivated, seen but not collected, Fosberg in 1956.

Malé; N. Mahlos; S. Mahlos; Kolumadulu. W & G p. 72. "Annáru."

Rhizophoraceae

Bruguiera cylindrica (L.) Bl.

Malé, Furannafuri I., common around saline pools near outer end of islet, Fosberg 36903. "Kandu" embryo radicle boiled and eaten.

Goifurfehendu; Kolumadulu; Miladumadulu. W & G p. 68 as Bruguiera caryophylloides Bl. "Kandu."

Rhizophora mucronata Lam.

Addu; Suvadiva; "in damp jungle all over the group." W & G p. 68.

Combretaceae

Lumnitzera littorea (Jack) Voigt

Malé. W & G p. 69 as Lumnitzera coccinea W. & A. "Kandu."

Lumnitzera racemosa Willd.

Suvadiva. W & G p. 69.

Terminalia catappa L.

Malé, Malé I., occasional in scrub at top of seaward beach, Fosberg 36833. "Mididi."

Malé; Kolumadulu; Goifurfehendu; Suvadiva; Addu; abundant all over the group. W & G p. 69. "Midili", "Medili", "Dommadu", "Gobu."

Lecythidaceae

Barringtonia asiatica (L.) Kurz

Malé, Furannafuri I., thicket in from beach, Fosberg 36900. "Kimbi."

Malé; S. Mahlos; Suvadiva; Addu. W & G p. 70 as Barringtonia speciosa Forst. "Kimbi."

Myrtaceae

Eugenia jambolana Lam.

Malé. W & G p. 70. "Lami."

Eugenia jambos L.

Malé; Addu. W & G p. 70. "Jumbu?"

Eugenia javanica Lam.

Malé; Malé I., cultivated, Fosberg 36876. "Jamburo." Fruit eaten.

Malé? W & G p. 70. "Jamburool."

Eugenia malaccensis L.

Malé; Addu. W & G p. 70. "Jumbu?"

Psidium guajava L.

Malé, Malé I., cultivated, seen but not collected, Fosberg in 1956.

Malé. W & G p. 70. "Féru."

Araliaceae

Polyscias guilfoylei (Bull) Bailey

Haddumati. W & G p. 74 as Aralia guilfoylei F. von M.

Myrsinaceae

Ardisia humilis Vahl

Suvadiva; Addu. W & G p. 79.

Sapotaceae

Mimusops elengi L.

Malé. W & G p. 80. "Munima."

Oleaceae

Jasminum auriculatum Vahl

Malé. W & G p. 80. "Kudima."

Jasminum azoricum L.

Malé, Male I., cultivated, Fosberg 36881. "Glenura ma."

Jasminum officinale f. grandiflorum (L.) Kobuski

Malé, Male I., cultivated, Fosberg 36882. "Wandu ma."

Malé; S. Mahlos; Goifurfehendu; Kolumadulu. W & G p. 80 as Jasminum grandiflorum L. "Huwanduma."

Jasminum sambac (L.) Ait.

Malé; S. Mahlos; Goifurfehendu; Kolumadulu; Haddumati; Addu. W & G p. 80. "Irudema", "Re Irudema."

Apocynaceae

Catharanthus roseus (L.) G. Don

Malé, Male I., cultivated, seen but not collected, Fosberg in 1956.

Malé. W & G p. 81 as Vinca rosea L. "Maliku ruva."

Nerium indicum Mill.

Malé, Male I., cultivated, seen but not collected, Fosberg in 1956.

Nerium oleander L.

Malé, Male I., cultivated, seen but not collected, Fosberg in 1956.

Ochrosia oppositifolia (Lam.) K. Schum.

Malé, Male I., occasional near outer beach, Fosberg 36824. "Dumburi."

Malé; S. Mahlos. W & G p. 81 as Ochrosia borbonica Gmel. "Dhumburi", "Dumburi."

Plumeria obtusa L.

Malé, Male I., cultivated, seen but not collected, Fosberg in 1956.

Plumeria rubra L.

Malé; Kolumadulu. W & G as Plumeria acutifolia Poir. "Gulu sampa", "Semper Beddha." P. 81.

Thevetia peruviana (Pers.) Merr.

Malé. W & G p. 81 as Thevetia nerifolia Juss.? "Hinbatu."

Asclepiadaceae

Calotropis gigantea (Willd.) R. Br.

Malé, Male I., common, Fosberg 36827. "Ruwa."

Malé. W & G p. 81. "Ruva", "Hudu ruva", "Rua."

Convolvulaceae

Convolvulus parviflorus Vahl

Malé; S. Mahlos; Goifurfehendu; Kolumadulu; throughout the group.
W & G p. 84. "Walu mirihi."

Evolvulus alsinoides L.

Malé; S. Mahlos; Haddumati. W & G p. 84. "Veo magu", "Meia limbo."

Hewittia bicolor W. & A.

S. Mahlos. W & G p. 84.

Ipomoea batatas (L.) Poir.

Malé; Addu; throughout whole group. W & G p. 83. "Oludukattala."

Ipomoea littoralis Bl.

Kolumadulu. W & G p. 84 as Ipomoea denticulata Chois.

Ipomoea pes-caprae (L.) Sweet

Malé; Goifurfehendu. W & G p. 84. as Ipomoea biloba Forsk. "Taburu",
"Thaburu."

Ipomoea quamoclit L.

Malé. W & G p. 83. "Kudiraïma-veyo."

Ipomoea tuba (Schlecht.) G. Don

Malé, Furannafuri I., very rare in Cordia-Pemphis thicket, sterile,
Fosberg 36902.

Goifurfehendu; Addu. W & G p. 83 as Ipomoea grandiflora Lam.

Ipomoea turpethum (L.) R. Br.

Malé. W & G p. 83. "Kurifila."

Merremia dissecta (Jacq.) Hall.f.

Malé, Malé I., climbing in scrub at top of seaward beach, Fosberg 36839.

Trichodesma zeylanicum (L.) R.Br.

Malé; N. Mahlos; Goifurfehendu; Addu. W & G p. 83. "Malebu."

Borraginaceae

Cordia subcordata Lam.

Malé, Furannafuri I., abundant in thickets on very stony ground, rare
on beaches, Fosberg 36905. "Kaani."

Malé; Goifurfehendu; Kolumadulu; Suvadiva. W & G p. 82. "Kani."

Messerschmidia argentea (L.f.) Johnst.

Malé, Kuda Bados I., occasional at top of beach, rare inland, Fosberg
36892. "Bori."

Malé; S. Mahlos; Goifurfehendu; Kolumadulu; N. Mahlos. W & G p. 82 as
Tournefortia argentea L.f. "Bori", "Mabori."

Solanaceae

Capsicum frutescens L.

Malé, Malé I., cultivated, seen but not collected, Fosberg in 1956.
Probably this species. Hot pepper sauce very widely used in
Maldivian food.

Capsicum minimum Roxb.

Malé; Goifurfehendu; Kolumadulu; Mahlos; Miladumadulu. W & G p. 85.
"Mirus."

Datura metel L.

Malé, Malé I., spontaneous in waste places, Fosberg 36842. "Hudu orani."
Malé; Miladumadulu; Kolumadulu; Addu. W & G p. 85 as Datura fastuosa L.
"Orhani."

Datura suaveolens H. & B.

Malé. W & G p. 86.

Nicotiana tabacum L.

Malé; Mahlos; Miladumadulu. W & G p. 86. "Dumpai."

Physalis minima L.

Malé; Goifurfehendu; Kolumadulu; sparsely in the whole group. W & G
p. 85. "Muraki."

Solanum melongena L.

Malé; Kolumadulu; Addu; cultivated in whole group. W & G p. 85. "Bari", "Kara"

Verbenaceae

Clerodendrum indicum (L.) Kuntze ?

Malé, Malé I., cultivated, seen but not collected, Fosberg in 1956.
Probably this species.

Clerodendrum inerme (L.) Gaertn.

Malé, Malé I., occasional near outer beach, Fosberg 36825. "Dungeti."
Malé. W & G p. 89. "Dugeti", "Dugajde."

Lantana mixta L.

S. Mahlos; "all over the north of the Archipelago." W & G p. 87.

Lippia nodiflora L.

Malé, Malé I., very general in open places, Fosberg 36858. "hiri dati."
Malé; Kolumadulu; Addu. W & G p. 88. "Hunigunditila."

Premna obtusifolia R. Br.

Malé, Malé I., common in scrub at top of seaward beach, Fosberg 36835.
"Dakanda."

Goifurfehendu; Suvadiva; N. Mahlos. W & G p. 88 as Premna integrifolia L.
"Kude", "Gelavalie."

Stachytarpheta jamaicensis Vahl

Malé, Malé I., occasional in open places, Fosberg 36821. "Malembu."
Malé. W & G p. 88 as Stachytarpheta indica var. jamaicensis.
"Malaembu", "Nunnay."

Tectona grandis L.

Malé. W & G p. 88.

Vitex negundo L.

Malé; S. Mahlos; Kolumadulu. W & G p. 88. "Dunnika."

Labiatae

Anisomeles ovata R. Br.

Malé; S. Mahlos; Goifurfehendu; Kolumadulu; Addu. W & G p. 90.
"Muskotan", "Maskota."

Leucas biflora R. Br.

Malé; Suvadiva; Addu. W & G p. 90. "Veo miri", "Veo mirihi."

Leucas zeylanica (L.) R. Br.

Miladumadulu; "also in other islands where yams are cultivated."
W & G p. 90.

Ocimum basilicum L.

Malé; N. Mahlos; S. Mahlos; Goifurfehendu. W & G p. 89. "Gandakoli."

Ocimum gratissimum L.

Malé. W & G p. 89. "Fonitulá."

Ocimum sanctum L.

Malé, Malé I., cultivated, seen but not collected, Fosberg in 1956.
Malé; N. Mahlos. W & G p. 89. "Kulitulá", "Gai Kehabuli."

Plectranthus zeylanicus Benth.?

Malé; Haddumati; N. Nilandu. W & G p. 89. "Huvadukotun", "Huvaduka."

Scrophulariaceae

Bacopa monnieri (L.) Pennell

Malé; Miladumadulu. W & G p. 86 as Herpestis monniera H.B. & K.
"Veppila."

Bignoniaceae

Tecoma stans L.

Malé, Malé I., cultivated, seen but not collected, Fosberg in 1956.

Acanthaceae

Barleria prionitis L.

Malé; Miladumadulu; Goifurfehendu; Kolumadulu; "cultivated everywhere."
W & G p. 86. "Dai kurandu", "Ma tumba", "Hai kurudo."

Justicia procumbens L.

Malé. W & G p. 87.

Pseuderanthemum carruthersii Seem.

Malé, Malé I., cultivated, Fosberg 36878.

Pseuderanthemum carruthersii var. atropurpureum (Bull) Fosb.

Malé, Male I., cultivated, seen but not collected, Fosberg in 1956.

Ruellia ringens L.

Malé; S. Mahlos; Goifurfehendu; Kolumadulu; Haddumati. W & G p. 86.
"Nita bodi", "Nitu badi."

Rungia parviflora Nees

Malé; Miladumadulu; Addu; "frequent in the group". W & G p. 87.

Rubiaceae

Borreria ocymoides (Burm.f.) DC.

S. Mahlos; "in many islands." W & G p. 76 as Spermacoce ocymoides Burm.f.

Guettarda speciosa L.

Malé, Malé I., occasional in scrub at top of seaward beach, Fosberg 36836. "Wuni."

Malé; S. Mahlos; Kolumadulu; "very common throughout the group."
W & G p. 75. "Uni."

Hamelia patens Sw.

Malé. W & G p. 75.

Hedyotis biflora (L.) Lam.

Malé; Goifurfehendu; S. Mahlos; Kolumadulu; "throughout the group."
W & G p. 75 as Oldenlandia biflora L. "Kudingaybelamaw," "Eyaganawatura",
"Beem magu."

Hedyotis corymbosa (L.) Lam.?

Malé. W & G p. 75 as Oldenlandia corymbosa L.

Hedyotis umbellata (L.) Lam.

Malé, Malé I., common in grassy area on top of old fort, Fosberg, 36909;
common in dense weedy sod back of beach, Fosberg 36857. "Em mudi."
Malé; S. Mahlos; Goifurfehendu. W & G p. 75 as Oldenlandia umbellata L.
"Emmuli."

Morinda citrifolia L.

Malé, Furannafuri I., occasional in coconut plantation, Fosberg 36904.
"Ahi."

Morinda citrifolia var. bracteata Hook.f.

Malé, Kuda Bados I., occasional in coconut plantation, Fosberg 36888.
"Ahi."

Malé; Goifurfehendu; Kolumadulu; S. Mahlos. W & G p. 76. "Ahi."

Goodeniaceae

Scaevola sericea Vahl

Malé, Malé I., dominant in scrub at top of seaward beach, Fosberg 36834. "Magu."

Malé; Goifurfehendu; Kolumadulu; "the most numerous shrub in the group."
W & G p. 79 as Scaevola koenigii Vahl. "Magu."

Compositae

Adenostemma viscosum Forst.

Malé; S. Mahlos; Kolumadulu; Goifurfehendu; Addu, W & G p. 77.
"Foni-loli."

Ageratum conyzoides L.

Malé; Haddumati. W & G p. 77. "Kochché-fai."

Artemisia vulgaris L.

Malé. W & G p. 78. "Mirajjé Kochchefai."

Blumea membranacea DC.

Kolumadulu; Haddumati. W & G p. 77.

Eclipta alba (L.) Hassk.

Malé; Kolumadulu. W & G p. 77. "Kalukadili."

Emilia sonchifolia (L.) DC.

Malé, Malé I., common in dense weedy sod back of beach, Fosberg 36855.

A dwarfed fleshy form found also on Ceylon beaches. "Hiri Kulla."

Malé; Goifurfehendu; in S. of Archipelago. W & G p. 78. "Hirikulla."

Lactuca polycephala Benth.

Goifurfehendu. W & G p. 78.

Launaea pinnatifida Cass.

Malé; Malé I., common in grassy area on top of old fort, Fosberg 36910.

"Hula fila." Used as potherb.

Malé; Goifurfehendu; N. Mahlos. W & G p. 78. "Dandu filia", "Kadapi",
"Kulla fila."

Synedrella nodiflora (L.) Gaertn.

Malé, Malé I., common locally in waste places, Fosberg 36851.

"Mirihivan kandidi."

Tithonia diversifolia A. Gray

Malé. W & G p. 78. "Bodu-mirihi."

Tridax procumbens L.

Malé, Malé I., very common generally, Fosberg 36865. "Mavina."

Vernonia cinerea (L.) Less.

Malé, Malé I., common, Fosberg 36874. "Walu kafa."

Malé; S. Mahlos; Goifurfehendu; Kolumadulu; common throughout group.

W & G p. 76. "Walu kafa."

Wedelia biflora (L.) DC. ex Wight

Malé, Malé I., common in inner edges of scrub at top of seaward beach,
Fosberg 36837. "Mirihi."

Malé; S. Mahlos; Goifurfehendu; Kolumadulu; common in entire group.

W & G p. 77. "Mirihi."

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